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Defense Science Board Task Force

on

B-52H Re-Engining

December 2002

Office of the Under Secretary of Defense
For Acquisition, Technology and Logistics
Washington, D.C. 20301-3140

OFFICE OF THE SECRETARY OF DEFENSE
3140 DEFENSE PENTAGON
WASHINGTON, DC 20301-3140

DEFENSE SCIENCE BOARD

MAR 20 2003

MEMORANDUM FOR UNDER SECRETARY OF DEFENSE (ACQUISITION, TECHNOLOGY & LOGISTICS)

SUBJECT: Final Report of the Defense Science Board (DSB) Task Force on B-52 Re-Engining

I am pleased to forward the final report of the DSB Task Force on B-52 Re-Engining. The task force was asked to review and advise on key aspects of the policy and technology issues associated with re-engining the USAF B-52 fleet. After careful examination of the relevant aspects of B-52 re-engining, the task force reached a unanimous conclusion to recommend the USAF proceed promptly with re-engining the B-52 fleet.

The attractive cost benefit and operational enhancements resulting from such an endeavor would substantially improve force employment flexibility. Significant collateral benefits also arise in reduction of tanker demand; reduced in-flight fuel consumption; and improved reliability, supportability and availability. The potential also exists to use an Energy Savings Performance Contract as a means to finance the B-52 re-engining, thereby minimizing the impact to the Service budget topline.

I endorse all of the Task Force's recommendations and propose you review the Task Force Chairman's letter and report.

William Schneider, Jr.
DSB Chairman

OFFICE OF THE SECRETARY OF DEFENSE
3140 DEFENSE PENTAGON
WASHINGTON, DC 20301-3140

DEFENSE SCIENCE BOARD

MAR 20 2003

MEMORANDUM FOR THE CHAIRMAN, DEFENSE SCIENCE BOARD

SUBJECT: Report of the Defense Science Board Task Force on B-52 Re-Engining

Attached is the final task force report. The task force was asked to review and advise on key aspects of the policy and technology issues associated with re-engining the USAF B-52 fleet.

The task force carefully examined relevant aspects of B-52 re-engining, including its impact on B-52 capability and demand for tanker support; fuel consumption; reliability, supportability and availability; technical risks of re-engining; and financing options, including the use of Energy Savings Performance Contracting.

The study resulted in seven conclusions:

1. The B-52H is the most versatile and cost effective weapon system in the bomber inventory and re-engining makes it even more so.

2. The B-52H has the highest mission capable rate of any of the three bombers, and remains the only Conventional Air Launched Cruise Missile (CALCM) capable platform in the inventory.

3 Further significant reduction in the B-52H fleet is considered unlikely for the foreseeable future because:
   - The total assigned inventory (TAI) bomber fleet being reduced from 130 to 96, a de minimis number
   - USAF has stated its intention to retain the B-52H through 2037
   - The B-52H is highly capability of accomplishing its assigned missions
   - The B-52H is flexible and able to adapt to future missions
   - The USAF chose to retire more than twice as many B-1 airframes as B-52H airframes
   - There is no bomber aircraft currently in development

4. B-52H re-engining represents low *technical* risk.

5 B-52H re-engining provides greater operational flexibility and range, reduces fuel burn and tanker demand, and produces significant depot and field maintenance cost and manpower savings.

6. B-52H re-engining is an excellent pilot program for expanding the use of Energy Savings Performance Contracts beyond fixed facilities and into mobile systems.

Table of Contents

Foreword

This report summarizes the work of the Defense Science Board task force on B-52H Re-Engining, which met 4 times between June and December 2002. This is the fourth look at the issue of B-52H re-engining since 1996. The approach taken by this task force differed in key respects from previous studies and some of the factors that were considered by previous studies have changed significantly since those studies were concluded.

The report uses eight sections to address two primary issues and provide conclusions and recommendations. Sections II through VII answer the question "Should the Air Force re-engine the B-52H?" The primary factors relevant to the decision include economic, operational, program risk, and environmental. Section VIII addresses the issue of how to finance the capital costs of re-engining, comparing the overall economic impact of various approaches, as well as legislative or other legal issues. Section IX presents the task force conclusions and recommendations.

Attachment 1: Task Force Terms of Reference
Attachment 2: Economic Summary
Attachment 3: TF33-103 Depot Price History and Future Trend
Attachment 4: Boeing's Break-Even Analysis

Executive Summary

In June 2002, USD(AT&L) commissioned a DSB task force to advise on the key issues associated with re-engining the B-52H Stratofortress. The Terms of Reference is at Attachment 1.

Overview

This is the fourth B-52H re-engining study conducted since 1996. The first three Air Force studies concluded re-engining was not economically justifiable. Several factors drove this conclusion: use of a constant fuel price at the Defense Energy Support Center's (DESC) rate; Air Force Material Command's estimate that engine depot cost would be stable through 2037; and the organizational judgment that required funding would not compete successfully against higher priorities. In addition, premature B-52H retirement and force reductions were considered program risks.

In the three years since completion of the previous study, cost, operational and business factors relevant to a re-engining decision have changed substantially. A 2001 DSB study calculated the cost of fuel delivered in-flight to be $17.50 per gallon, using USAF provided figures, excluding the capital cost of tankers. Previous studies valued all fuel at about one dollar per gallon. The actual depot price for TF33-103 maintenance is now nearly triple previous estimates; and the cost continues to rise. Further, the primary assigned aircraft (PAA) bomber force has been reduced from 130 to 96, making further material force reductions less likely.

Direct costs, such as fuel and maintenance, are easily quantified in a cost-benefit spreadsheet analysis. Operational value is not. A re-engined B-52H delivers a significant increase in unrefueled range, reduces demand for fuel and tanker assets, and increases loiter time. Recent changes in the threat environment, new operational applications for the B-52H, and changing future mission utilization concepts also increase the operational value of re-engining.

Affordability issues can be addressed using Executive Order 13123. This directive opens the possibility for the private sector to fund the capital costs to upgrade mobile equipment, and to be repaid from resulting decreases in operations and maintenance outlays. Although this approach results in a higher overall program cost, it has been used in lieu of appropriated funds to modernize fixed installations since 1988. It has not yet been used for mobile equipment. B-52H re-engining may be an appropriate pilot program.

This task force concluded that the economic and operational benefits far outweigh the program cost; and unanimously recommends the Air Force proceed with B-52H re-engining without delay.

The Cost of Fuel

The task force used recent USAF provided B-52H fuel consumption data to baseline current fuel costs and to estimate savings from re-engining. The cost to the Air Force for ground-provided fuel is the DESC price plus about 20 cents for delivery infrastructure. Based on data provided by the USAF to the DSB task force that authored the 2001 report "More Capable Warfighting Through Reduced Fuel Burden", airborne fuel delivery costs the Air Force about $17.50 per gallon. B-52H re-engining reduces overall fuel consumption by about 35 percent. Demand for in-flight refueling is scenario-dependent. This makes it difficult to definitively quantify the resulting total reduction in tanker demand over the remaining life of the B-52H and to assign a dollar value to it for the purpose of conducting a cost-benefit analysis. However, based on scenarios examined by the task force, overall B-52H in-flight refueling demand would be reduced by between 50 and 66 percent after re-engining. The task force estimates the economic value of reduced fuel demand, including in-flight sources, to be between $6B and $9B through 2037, depending on whether or not tanker acquisition costs are included. (See Attachment 2). The task force recommends OSD sponsor an independent study to refine the estimated impact of B-52H re-engining on total tanker demand.

The Cost of Engine Depot Overhaul

Previous Air Force studies, using Air Force Material Command figures, estimated the depot overhaul cost of a TF33-103 engine to be $257K (FY96$). Further, previous studies assumed cost would remain relatively constant over the remainder of the weapon system's life (until about 2037) and would never exceed $300K. This estimate is no longer valid. (See Attachment 3). Between 1996 and 2001, the per-engine overhaul price rose from $257K to $539K. The current FY03 price is $710K--an increase of 176% since 1996. Currently, Boeing and the B-52H System Program Office estimate that an annual real cost growth of 2% over the remaining economic life of the airframe is a reasonable planning assumption, putting the depot cost for each engine at about $1.4M by 2037.

The Cost of Engine Maintenance

Long-term experience with TF33-103 engine reliability indicates that approximately 87 engines will be removed from the current B-52H fleet each year for depot overhaul. On the other hand, today's new commercial turbofan engines are so reliable that the task force estimates that in a re-engined B-52H fleet, no engine removals would be necessary for the remainder of the B-52H's economic life unless caused by unforeseen failures, such as severe foreign object damage (FOD), combat damage, or equipment defects. As a result, all engine work would be "on pylon" for the remaining life of the B-52H fleet. This has significant implications for depot capability, logistics provisioning and maintenance manning. Current widespread commercial use of these engines would also minimize the need to pre-purchase spares, instead allowing a business-like opportunity to negotiate contracts for a one-for-one exchange should an

unexpected failure occur. Also, wide commercial use of the proposed engine candidates makes contracting for all on-aircraft maintenance feasible, essentially eliminating the need for uniformed engine support on base or at depot. The task force estimates the total value of reduced depot and field maintenance demand to be approximately $3B through 2037.

Annual Airframe Utilization

Previous studies assumed that each B-52H would fly about 350 hours per year in its traditional roles - high altitude conventional and nuclear SIOP missions. For the past two years, about half the fleet has experienced about one additional year's worth of flying. Higher annual utilization increases the benefit of prompt re-engining and accelerates the time value accrual of benefits.

Airframe Life

The B-52H airframe life is estimated at between 32,500 and 37,500 airframe hours based on traditional mission profiles. The upper wing surface is the limiting structural member. The task force consulted with the USAF and Boeing to reaffirm this estimate. As of 1999 the average airframe had 14,700 flight hours. Re-examining past data in light of emerging mission profiles, both the System Program Office and the task force judge that the airframe life is greater than the current estimate. The current estimate assumes continuation of the structurally stressful low-level mission, which has not been experienced by the airframes nor practiced by aircrews for many years. The B-52Hs emerging profile as a long range conventional delivery platform (such as its role in Afghanistan), with employment concepts such as long loiter with high density standoff precision munitions or as an anti-ballistic missile platform, would be less stressful than current profiles, further extending the airframe life.

The Risk of Premature Retirement

Previous studies assumed that the USAF bomber fleet would remain constant at 208 Total Aircraft Inventory (TAI) (94 B-52H; 93 B-1; 21 B-2), and cited the economic loss from premature retirement of aircraft to be a significant program risk. However, the total force is now being reduced substantially to 157 aircraft (76 B-52H, 60 B-1; 21 B-2). The total operational fleet for combat tasking is being reduced from 130 to 96. The B-52H continues to accomplish its assigned missions remarkably well. Although the number of available Primary Assigned Aircraft (PAA) bombers is extremely low, the USAF has recently retired more than twice as many B-1s as B-52Hs. Additionally, there is no bomber aircraft currently in development. These factors led the task force to conclude that further significant reductions in the B-52H fleet are unlikely for the foreseeable future.

Operational Benefits from Re-engining

In addition to reduced tanker demand and reduced direct operating costs, re-engining produces substantial operational benefits. In terms of aircraft performance, unrefueled range increases 46%, while fuel consumption decreases about 35%. This means a 10,000-mile B-52H mission (US to Afghanistan and return) would require only one tanker refueling rather than the current two. Fuel offload demand declines from 276 Klbs to 118 Klbs, decreasing the claim on the high demand tanker force. Using a notional sortie regime and weapon loadout from Diego Garcia to Afghanistan, a B-52H with 25% greater unrefueled range could have conducted its OEF missions with 66% fewer in-flight refuelings. A 46% range increase would produce the combined benefits of accomplishing the mission with 66% reduction in tanker demand plus 4.7 hours of loiter time. Currently, the B-52H cannot fly from Diego Garcia to Afghanistan without refueling. Tanker availability was often a problem that constrained planning and executing Operation Enduring Freedom (OEF) missions.

Environmental Effects of Re-Engining

The task force considered local air quality, global climate change and community noise impacts of re-engining. Considering only the B-52H fleet, and not the reductions associated with reduced tanker use, emissions of carbon dioxide, carbon monoxide and smoke would decrease by 30% or more whereas emissions of oxides of nitrogen are expected to increase by roughly a factor of two. Community noise impacts would be reduced significantly, with about half the annoyance per operation. Re-engining will bring the B-52H into compliance with current emissions standards of the International Civil Aviation Organization (ICAO) and Federal Aviation Administration (FAA) Stage III noise standards. The task force judges these changes to be favorable, particularly when the benefits of reduced tanker usage are considered.

Recapitalization Costs

The past three studies estimated recapitalization costs for re-engining, including all associated program costs, to be approximately $3B. Of that amount, the estimated cost of off-the-shelf engines was $1.5B ($FY96). In consultation with AFMC, Boeing, and three potential engine providers, the task force estimates the cost of re-engining to be between $3B and $3.5B, depending on start and completion dates and the financing method chosen. The current highly competitive business climate for airframe and engine manufacturers offers the government a window of opportunity to negotiate very favorable terms.

Innovative Financing

The cost to re-engine the B-52H is financially demanding. To address this issue, Boeing introduced the concept of using an Energy Savings Performance Contract (ESPC). It appears both possible and sensible for the Air Force to consider this approach. In 1999, Executive Order 13123 opened the possibility for ESPCs to permit private capital to be used to improve the energy efficiency of government-owned mobile equipment. Under this arrangement, the private sector funds the re-engining program's capital cost and is repaid over time from the savings generated in reduced O&M outlay. However, profit to the financier and interest on the money increase the total program cost and decrease the total economic benefit to the government, compared to a traditional acquisition. The task force interpretation is that all O&M costs currently linked to B-52H engine activities that are reduced as a result of re-engining would be eligible to be used for repayment. This includes all reductions in maintenance personnel and facilities; logistics personnel, systems, and support; depot activities devoted to supporting current engines and spares; and depot personnel devoted to the TF33-103. In other words, the annual cost of financing the re-engining under a successful ESPC would be would be no greater than the current cost for operating, maintaining, sustaining, and overhauling the B-52Hs current TF33-103 engine throughout its remaining life. This includes all costs associated with operating and maintaining the number of tanker aircraft equal to the tanker capacity demand made redundant by re-engining. These costs are captured by the $17.50 cost per gallon of fuel delivered by tankers. Boeing's spreadsheet analysis (Attachment 4) shows that 2031 is the estimated break-even year for this financing strategy.

Other Considerations

The B-52H has the most flexible carriage capability of any of the three bombers and is the only Conventional Air Launched Cruise Missile (CALCM) capable platform. If the USAF decides to re-engine the B-52H, the capability for explosive engine starts would be lost. If an operational requirement for self-starting exists, the USAF should conduct a separate evaluation to determine feasibility of installing an internal APU. It was the view of the task force that an engine self-start capability no longer appeared to be a core need. The issue of self-start capability is an operational decision to be made by the USAF.

Conclusion

The task force concludes B-52H re-engining is an attractive opportunity for the following financial and operational reasons:

- USAF's intent to retain the B-52H through 2037
- Improved operational benefits
  - greater range
  - reduced fuel burn
  - reduced tanker demand

- High engine reliability eliminating off-airframe engine maintenance
    - o logistics savings
    - o depot manpower savings
    - o field maintenance manpower savings, and
- The innovative financing opportunity with neutral year-to-year budget impact using ESPC.

Recommendation

The task force recommends the Air Force promptly:

- Re-engine the B-52H because of its attractive cost benefit and operational enhancements that substantially improve force employment flexibility, and:

- Place the program put on a fast acquisition track in order to maximize the benefits and take advantage of the current business climate.

Attachment 1: Terms of Reference

ACQUISITION, TECHNOLOGY AND LOGISTICS

THE UNDER SECRETARY OF DEFENSE
3010 DEFENSE PENTAGON
WASHINGTON, DC 20301-3010

26 JUN 2002

MEMORANDUM FOR CHAIRMAN, DEFENSE SCIENCE BOARD

SUBJECT: Terms of Reference -- Defense Science Board Task Force on B-52 Re-Engining

You are requested to form a Defense Science Board (DSB) Task Force to review and advise on key aspects of the policy and technology issues associated with re-engining the USAF B-52 fleet.

This weapons system, first placed into service in the late 1950s and last manufactured in 1962, will likely remain in remain in inventory as late as 2040. Given its projected use in a variety of scenarios and situations, it is prudent to consider steps to ensure its continued viability.

The Air Force has recently modernized the KC-135 tanker an RC-135 fleets with new engines. Given the projected retention of the B-52 for several decades into the future, it is prudent to examine and assess B-52 re-engining from the perspectives of:

- effective operational weapons system employment, to include tanker demands;
- efficient ground and flight operations, to include fuel consumption factors;
- engine reliability and systems performance;
- technical and supportability risks of remaining with the TF-33 engine;
- streamlined support concepts from a best value viewpoint, to include total contractor support;
- implementation issues, to include conventional as well as innovative acquisition and financing;
- contracting and legal considerations- -to include termination issues; and

affordability of re-engining as compared to life extension concepts

This study should take no more than 90 days. Completed work should be submitted to the office of the Defense Science Board Secretariat not later than September 30, 2002.

The Task Force will be sponsored by me as the USD (AT&L). The Director, Strategic and tactical Systems (S&TS) will support the task force. General Michael P. C. Carns, USAF (Ret.) will serve as the Task Force Chairman. Col Jon Link, (S&TS-AW), will serve as the Executive Secretary. LtCol Roger W. Basl will serve as the Defense Science Board Secretariat representative.

The Task Force will operate in accordance with the provisions of P.L. 92-463, the "Federal Advisory Committee Act" and DoD Directive 5105.4, the "DoD Federal Advisory Committee Management Program." It is not anticipated that this Task Force will need to go into any "particular matters" within the meaning of section 208 of Title 18, U.S. Code, nor will it cause any member to be placed in the position of acting as a procurement official.

E. C. Aldridge, Jr.

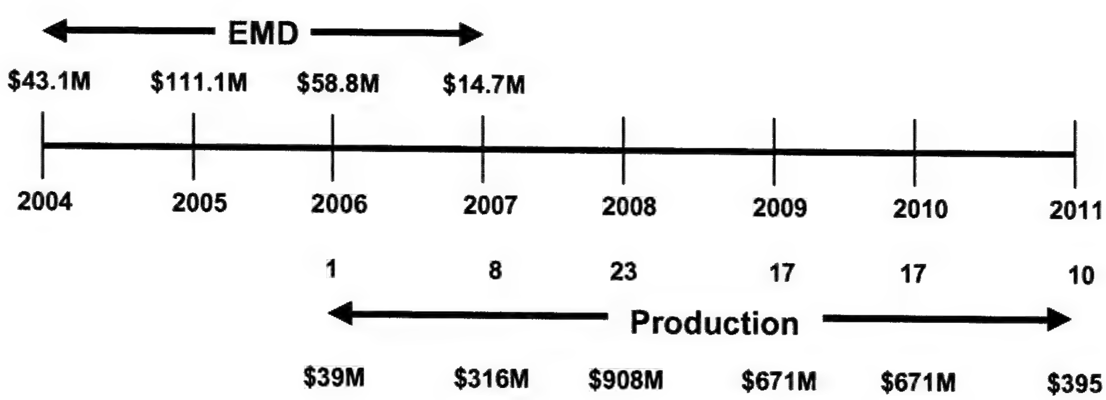
Attachment 2: Economic Summary

	Current Outlay	Outlay After Re-Engining	TOA Reduction
Fuel Purchase	87.4	55.6	31.8
Depot Maintenance	61.8	0	61.8
Field Maintenance	32	13	19
Total	181.2	68.6	112.6

Estimated Single Year Change in Direct O&M Outlay in Current Dollars
(Figures in millions dollars)

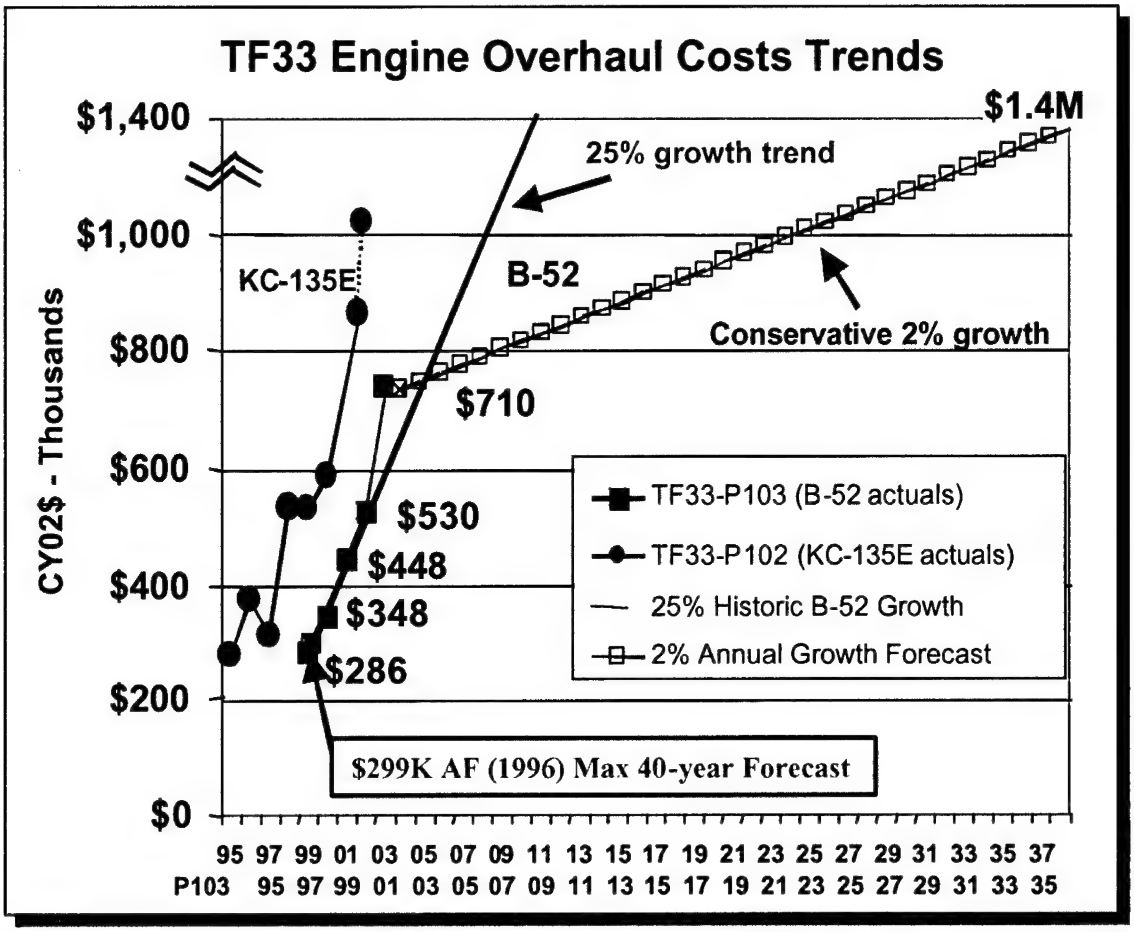
	Current Outlay	Outlay After Re-Engining	TOA Reduction
Fuel Purchase	6,308	4,490	1,818
Depot Maintenance	4,459	0	4,459
Field Maintenance	2,337	1,680	657
Total	13,104	6,170	6,934

Estimated Total Lifetime Change in Direct O&M Outlays With Re-Engining
(Figures in millions dollars)



Estimated Program Schedule and Cost

Attachment 3:
TF33-103 Depot Price History and Future Trend

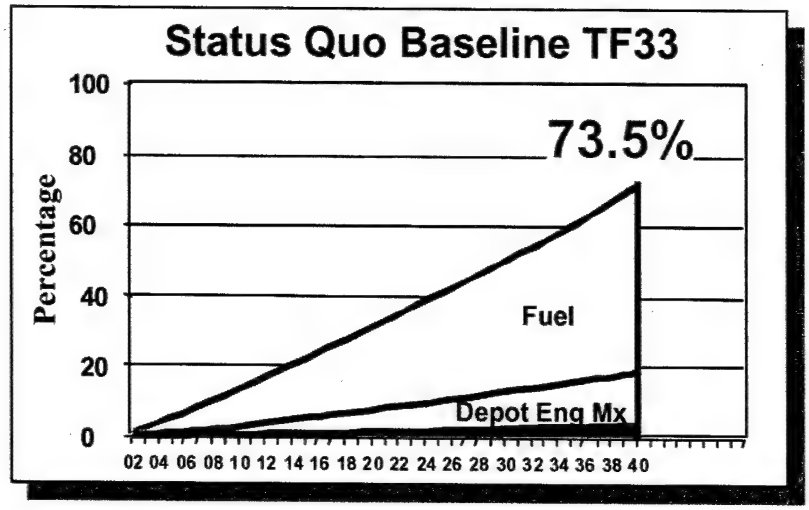


During the initial Air Force economic analysis of re-engining, the price charged to the B-52H program office was $257,000 per TF33-103 engine. In their analysis, the Air Force judged this price would never exceed $300,000 over the remaining life of the B-52H. However, in FY02, the depot sales price rose to $539,000 and in FY03 it increased again to $710,000.

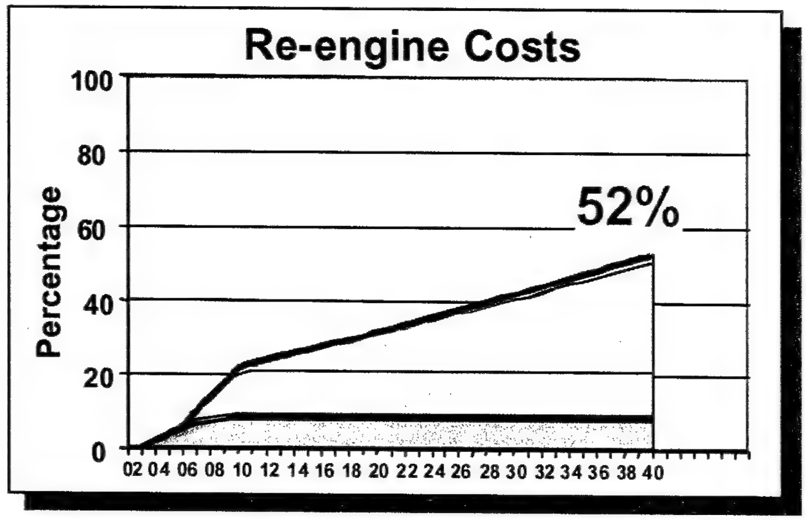
The increases were based on a more accurate accounting by the depot of actual cost of maintaining the engine, and the price is now consistent with prices in the private sector for maintaining comparable engines. The table above reflects these increases and projects various scenarios through the end of the estimated B-52H airframe life.

Attachment 4: Boeing's Break-Even Analysis

These charts compare the cost and savings as a percentage of a constant dollar figure. The data is presented in this way to preserve proprietary cost data.

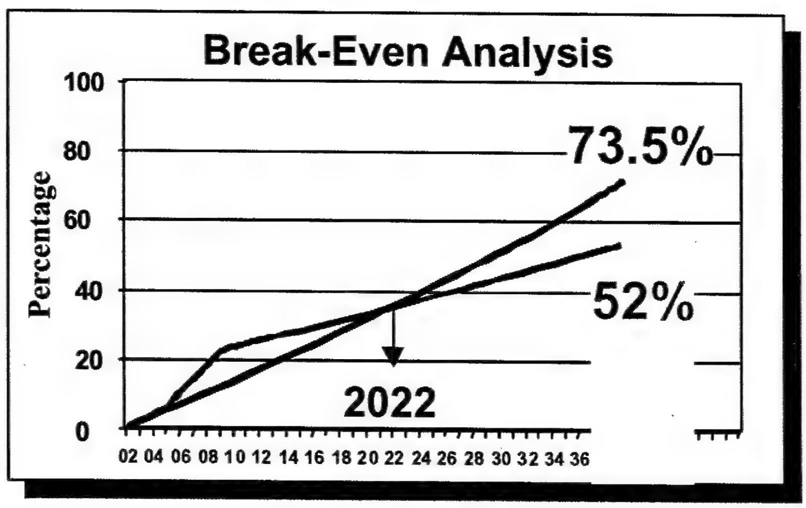


The top chart shows the current operating costs of the B-52H fleet over the projected remaining life of the B-52H airframe.



The middle chart shows how the total cost to the Air Force of the B-52 fleet, including re-enging program costs.

The point at which the lines cross is the point at which annual outlays for the re-engined fleet falls below those projected for the baseline fleet.



Based on the estimated costs, and savings, this point is projected to occur in 2022.

I. Introduction

In July 2002, the Under Secretary of Defense for Acquisition, Technology and Logistics commissioned a Defense Science Board (DSB) task force to review and advise on key issues affecting a decision to re-engine the USAF B-52H fleet. The task force Terms of Reference is at Appendix A.

This is the fourth look at re-engining the B-52H since 1996. The approach used in this study differs significantly from previous assessments in some important ways. Unlike previous studies, this task force includes the true cost of in-flight refueling in its life cycle cost analysis, rather than using the price paid by the Services to DESC for fuel. Depot maintenance costs for the existing engine have risen far higher than were considered reasonable by previous studies. Operationally, major improvements in the standoff range and accuracy of munitions now enable the B-52H to perform missions previously considered unsuitable, principally the CAS mission. The Boeing Company has also proposed using a private sector financing model that avoids the need for large, up-front appropriations. The Energy Savings Performance Contract (ESPC) concept uses private capital to execute the program, and links a payment schedule to operations and maintenance savings over the remaining life of the B-52H. This is not a new concept. ESPCs have been used successfully to fund facility upgrades for some years. In the case of re-engining, the funds would be paid back from reduced fuel and maintenance costs and reduced requirements for tanker aircraft.

In 1996, the Boeing Company presented the Air Force with an unsolicited proposal to modernize the B-52H by replacing the 8 existing 1950s vintage TF33-103 engines with 4 modern, commercial-off-the-shelf RB-211 engines produced by Rolls-Royce. The Air Force convened an Integrated Product Team (IPT) to conduct a Life Cycle Cost (LCC) study. The key assumptions driving the results of the LCC were:

- The value of fuel savings would accrue at a constant 87 cents per gallon (the Defense Energy Support Center standard price at the time) over the remaining 40 year airframe life
- Total Engine Removal Rate (TER) per 1000 flying hours of 0.986
- Depot engine sales price of $257,000, never to exceed $300,000 over the remaining 40 year life of the airframe

The IPT concluded it was not cost effective for the Air Force to re-engine the B-52H. The Air Force LCC estimated leasing the engines from Boeing would impose a burden on AF TOA of $1.314B between FY97 and FY36. Boeing's LCC estimated leasing the engines would free $4.755B from the AF TOA between FY97 and FY36.[1]

In 1998, the AF re-accomplished the analysis comparing 4 options:

- Do nothing

[1] Air Force Re-Engining IPT Final Report – Analysis of the Boeing Unsolicited Proposal to Re-Engine the B-52H, Undated

- Modernize the existing TF33-103 engine, resulting in 2% efficiency improvement
- Replace with the RB211, resulting in 33% efficiency improvement
- Replace with the PW2040, resulting in 27% efficiency improvement

The result of the LCC showed re-engining was still not cost effective. Modernizing the TF33-103 had a marginally better net present value (NPV) ($2.989B) than doing nothing ($3.220B). The Air Force analysis showed all other options to be considerably more costly.

Subsequently, the Air Force's Aeronautical Systems Center (ASC/LPJ) was tasked to update the 1998 study. They conducted a "back of the envelope" calculation, updating the contractor proposals for inflation and obtaining new operational data from OC-ALC. Again, the conclusion was that re-engining was not cost-effective.

This current DSB study was tasked to look more broadly at the issue than past studies. Specifically, the Terms of Reference required the task force to investigate the value of reduced tanker demand resulting from the greater efficiency of the new engines. Other relevant factors also changed significantly. Principally, when the AF IPT evaluated the 1996 Boeing proposal, it used $257,000 as the depot cost for a TF33-103 engine, and stated the price would never exceed $300,000. For FY 2002, the depot cost was $530,111 and on October 1, 2002 the FY2003 price increased to $710,000.

The 1996 Boeing proposal was prepared at considerable expense to the Boeing Company. It was only offered for a limited time, and is no longer available. However, Boeing presented the Air Force with a revised concept in August 2002 to conduct a comprehensive study on the costs and benefits of re-engining and to develop a program. Their analysis of the costs and benefits are based partially on the 2001 Defense Science Board Task Force report "More Capable Warfighting Through Reduced Fuel Burden." The new Boeing concept is for a $3 Million Air Force funded study to develop a new proposal.

The concept of using the true cost of in-flight refueling to determine the cost effectiveness of increasing the efficiency of receiver aircraft was proposed in a 2001 Defense Science Board Study titled "More Capable Warfighting Through Reduced Fuel Burden." The study recommended including the value of reduced tanker demand resulting from more efficient engines in the cost effectiveness calculations. It also noted that in order to access these savings, tanker force structure must be realigned as indicated by the reduced demand.

In order for re-engining to be cost effective, the B-52H must be capable of remaining in service long enough to return the investment. This means the airframe must have adequate remaining service life and the platform must remain capable of conducting its required missions. The task force has received no information indicating either of these conditions cannot be met.

II. The Economics of Re-Engining

II.a – The Cost of Fuel

The B-52H fleet is programmed to fly about 22,000 hours per year and with existing engines it consumes 3,310 gallons per hour. After re-engining, the hourly fuel consumption rate is calculated to decline by about 33 percent, to 2,218 gallons per hour. At the programmed flying hours, this is a savings of about 24 million gallons of fuel per year, or 840 million gallons over the remaining 35-year economic airframe life of the B-52H. Previous re-engining studies calculated the economic value of this reduction by multiplying the number of gallons saved times the prevailing Defense Energy Support Center (DESC) price for fuel. This is the price the Services pay to purchase fuel from DESC.

Based on the DESC FY03 price of $1.20, the methodology used in previous studies would produce an economic savings of about $29 Million per year or about $1.0 Billion over the estimated 35-year remaining life of the B-52.

While using a common price for fuel delivered to any of DESC's terminals makes sense as a cost accounting simplification, using it as the basis for making investment decisions does not. The reason is the DESC price does not include the costs the Services pay for logistics needed to move the fuel from the DESC point of sale to its point of use. In its 2001 report "More Capable Warfighting Through Reduced Fuel Burden", a Defense Science Board task force calculated the true cost of delivering fuel in-flight in FY99 was about $17.50 per gallon. The Air Force Cost Analysis Improvement Group (CAIG) calculated this figure based on a request from the task force. The figure represents the total cost of operating and maintaining the Air Force fleet of tanker aircraft divided by the number of gallons of fuel delivered by tanker aircraft during the year FY99, the most recent data available to that task force. Calculating the true cost of fuel in this way highlights the cost of the logistics for delivering fuel, and represents a theoretical savings available by reducing demand for logistics. In FY2001, tankers delivered about 10.8 percent of the fuel burned by the B-52H fleet.

Because the cost of in-flight delivered fuel is embedded in the cost of operating the tanker assets used to deliver the fuel, these savings can only be accessed by reducing logistics assets. In this case, reducing the demand for a gallon of in-flight refueling theoretically eliminates the need for $17.50 worth of logistics assets. But it is not possible to eliminate a fraction of a tanker aircraft. A tanker requirements model is used to determine the total tanker requirement, and the fuel burn rate of receiver aircraft is an element of that model. The 2001 DSB task force noted that inserting a re-engined B-52H into the tanker requirements model in use at that time resulted in a reduction of between 55 and 83 tanker aircraft. The range of uncertainty was because complete information about the model used to establish tanker requirements was not available to the task force.

There are two ways of interpreting this result. First is the figure represents the number of tanker aircraft no longer required. Second, is the figure represents the number of tanker aircraft effectively "purchased" by re-engining. The interpretation used will

depend on whether or not the Air Force currently owns adequate tanker assets. If there are adequate tanker assets, the figure represents aircraft that can be retired from inventory. If there is a shortage, the figure represents the number of tanker aircraft available for "purchase" through re-engining. Either way, the value of the 55 aircraft represents part of the value of B-52H re-engining.

It is a simple matter to determine whether it is cheaper to purchase tanker capacity by re-engining or by maintaining tanker aircraft. The Air Force currently spends $386 Million annually to maintain 137 KC-135E model tankers, or about $2.8 Million per aircraft.[2] Using the conservative number of 55 tankers, assuming constant maintenance costs and adequate KC-135E airframe life and discounting any tanker acquisition costs, the Air Force can purchase tanker capacity worth $154 Million per year, or $5.39 Billion over 35 years assuming zero discount rate, for the cost of the B-52H re-engining program.

However, the tanker requirements study used to calculate the 55 tanker figure has been superceded, according to a briefing by Air Mobility Command. They briefed this task force on their new model for determining tanker requirements, called TRS-05, or Tanker Requirements Study for FY05. The total tanker requirement established by TRS-05 is the sum of air tankers used for refueling roles, operational withholds, airlift, deployment and, employment for scenarios involving various combinations of MTW-SWA, MTW-NEA, SIOP, SSC, and SOF. The conclusion was that 500 - 600 aircraft are required (KC-135R equivalents) assuming an 85% mission capable rate, not including depot and training. The model did not include an ability to investigate the connection between improved bomber efficiency and tanker requirements.

The details of the model that would be necessary to determine the tanker equivalent value of B-52H re-engining were unavailable to this task force. However, based on the limited data available, the impact of re-engining on overall tanker requirements using the 1996 tanker requirements model appears to be consistent. In addition to a lack of transparency, the task force had a number of other concerns based on what it was able to learn about the model. TRS-05 assumes a 2 MTW capability, and not the current 4-2-1 construct. It contains no provisions for conducting sensitivity analyses to determine the impact on total tanker requirements over time of changes in receiver aircraft, including the B-52H. Finally, the model focuses on what the tanker requirement will be in FY05 at a time the Air Force is considering major tanker procurement.

The $17.50 marginal value of a gallon of in-flight delivered fuel from the 2001 DSB report would change considerably if the question were how many KC-767s were required to replace the existing 137 KC-135Es. This is because maintenance costs would decline but acquisition costs would be added to the calculation. To bring down the high cost of tanker maintenance and address the problem of high non-mission capable (NMC) rates, the Air Force is investigating the possibility of replacing its 137 KC-135E models with 100 Boeing 767 commercial aircraft configured as tankers. This task force recommends OSD commission an independent study to determine whether the total life cycle cost to the Air Force would be less by offsetting some of the 767 tanker buy with re-

[2] AMC/XPY Briefing to DSB Task Force, July 15, 2002

engined B-52Hs. A back-of-the-envelope calculation suggests diverting approximately $3.5 Billion from the KC-767 program to B-52H re-engining may net a greater capability at a lower cost.

The task force also recommends OSD commission a new independent long-term tanker requirements study. The methodology should extend beyond FY05, be based on new planning guidance, and include the ability to conduct sensitivity analyses of B-52H re-engining as well as other planned and potential new receiver aircraft that will be in service over the expected lifetime of the tanker force, such as JSF. The model should be also transparent in terms of factors, assumptions and methodology.

II.b – The Cost of Engine Depot Overhaul

The original Air Force IPT evaluation of the 1996 Boeing proposal used $257,000 as the depot cost of the TF33-103, and stated "Boeing's estimate of $426,000 "grossly overstates the true cost associated with depot maintenance." In FY02, the depot sales price rose to $539,000. On October 1, 2002 the FY03 price became $710,000. This increase is part of revenue-neutral cost accounting changes at the depot, designed to more accurately align charges against specific systems with actual costs. As a result, this new price more accurately reflects the true cost of maintaining the TF33-103 engine.

A comparison with the commercial sector reveals the current depot price of $710,000 for the TF33-103 is consistent with private sector experience. As relevant data points, the average commercial repair for a large engine (PW-4000 class) is approximate $1.5 Million, and for a smaller engine is about $700,000. The largest engines cost about $2.5 Million for an off-wing repair.

Figure 1 shows actual and projected cost growth for the TF33-103 engine. In its briefing to the task force, the B-52H System Program Office at Oklahoma City Air Logistics Center said that, barring any further accounting changes, 2 percent real cost growth is a realistic projection for future depot pricing. Projecting forward, this places the estimated depot price at the end of the projected B-52H airframe life at around $1.4 Million each.

In order to compare the projected maintenance of the TF33-103 with proposed replacements, the task force received briefings from 3 COTS engine manufacturers with engines that appear suitable for use on the B-52H; the Rolls-Royce RB-211, the Pratt & Whitney PW 2040, and 3 options from General Electric.

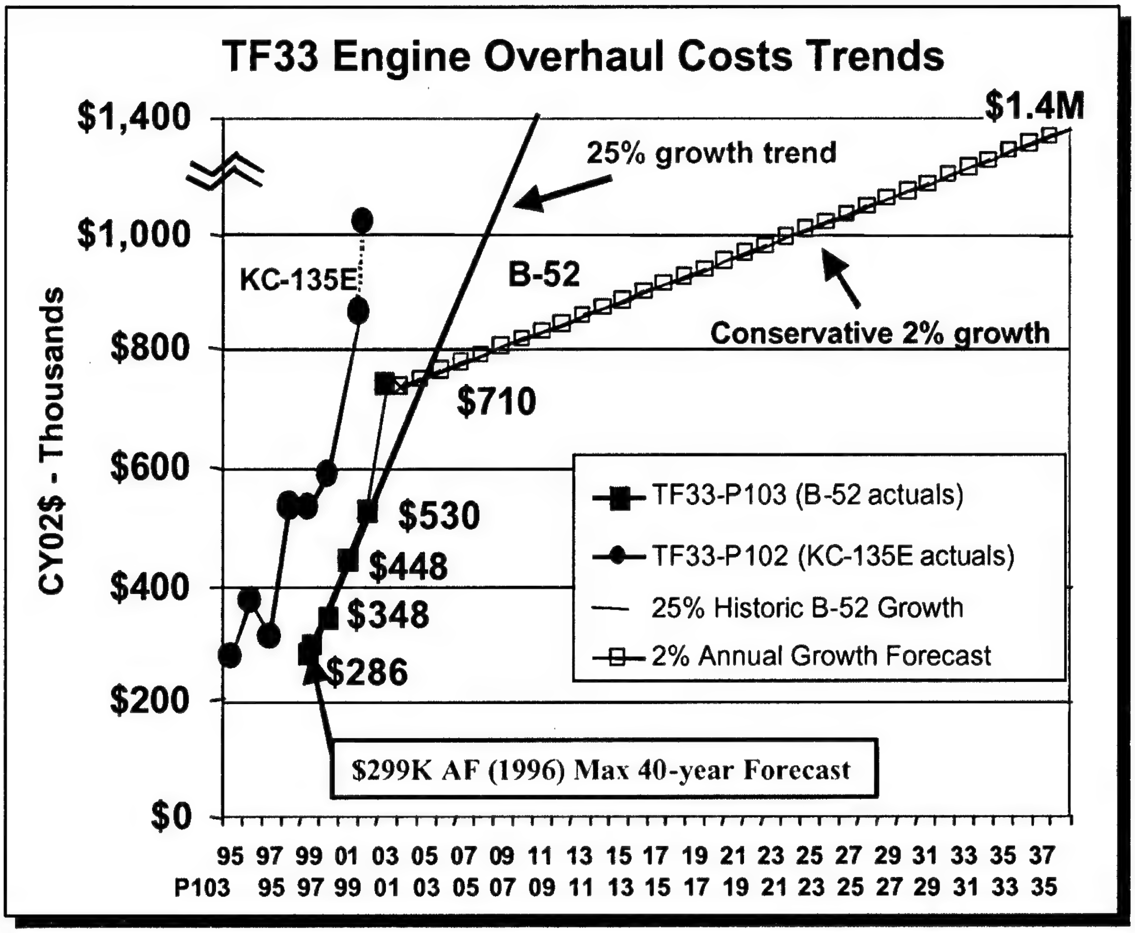


Figure 1: TF33-103 Depot Price History and Future Trend

Engine removal rates for today's commercial engines are very low. This is primarily a function of the technical advances made in engines over the past 30 years. Today's new commercial engines can last 10,000 to 15,000 hours between initial installation and first off-wing repair. For the B-52H re-engining, the time interval between installation and first off-wing repair is projected to be greater than the remaining hours left on the airframe, making re-engining essentially a "hang and forget" program. While typical standard deviations in engine durability suggests that several of the engines will have to be overhauled before 2037, the task force would expect adequate guarantees in the contract to keep the Air Force from having to bear the financial burden for the "lemons."

Following initial off-wing repair, the cycle shortens. The typical engine flown domestically will remain on-wing for about 5,000 hours and about 4,000 cycles after it's initial removal. A typical engine flown internationally will remain on-wing for about 11-12,000 hours or 2-3,000 cycles after its initial removal. Based on this, the estimated depot costs for re-engined B-52Hs will be only for unanticipated engine failures.

The task force estimates that assuming no further real cost growth in engine price and 3.9 percent discount rate, the economic value of depot maintenance savings over the remaining life of the B-52H airframe from re-engining to be approximately $4.5 Billion.

II.c – The Cost of Engine Maintenance

In addition to the engines sent for depot maintenance, about 70 engines a year undergo field maintenance on the aircraft. Each engine costs an average of $462,400 to repair, for a total annual cost of $32 million per year. Boeing estimates that after re-engining, the total annual field maintenance costs to the Air Force for the inventory of B-52H engines will be approximately $13 Million. Options for complete contract maintenance hold the possibility of reducing active duty aircraft maintenance end strength. Extrapolating over the remaining life of the B-52H airframe, this reduction in field maintenance costs represents a savings of about $0.68 Billion.

II.d – Annual Airframe Utilization

Previous studies assumed that each B-52H would fly a total of about 350 hours per year in its traditional roles - high altitude conventional and nuclear SIOP missions. Due to deployments in the Gulf in support of Operation Enduring Freedom and other taskings, a portion of the B-52H fleet was flown significantly greater hours. Specifically, for the past two years about half the fleet has, on average, experienced about one additional year's worth of flying. This increase is currently insignificant relative to the remaining life of the fleet because of the range of uncertainty in the model used to predict economic lifetime and the uncertain impact of eliminating the low level mission.

Higher annual utilization does increase the financial and operational benefits of prompt re-engining. It accelerates the time value accrual of economic benefits and provides greater operational capability sooner, in terms of increased B-52H range, reach and loiter and increased availability of tanker assets to support other missions.

II.e – Economic Summary

The key O&M outlay savings streams resulting from re-engining include:

- Fuel (commodity only included here, not the value of decreased tanker demand)
- Depot Maintenance
- Field Maintenance

Re-engining reduces hourly fuel consumption from 3,310 gallons per hour to 2,218 gallons per hour. The B-52H fleet is programmed to fly 22,000 hours per year for about 35 years. The lifetime savings is about 840 million gallons of fuel. Assuming no growth in fuel price and a 3.9 percent discount rate, at the current DESC commodity price for fuel[3], TOA outlay would decline by nearly $1.8 Billion.

[3] DESC FY03 Standard Price for JP-8 is $1.20

Each year, 87 B-52H engines are removed from the aircraft and sent to depot at a price of $710,000 each, or nearly $62 Million per year. Assuming no real cost growth, no increase in the rate of engine removals and 3.9 percent discount rate, this totals $4.46 Billion over the remaining life of the B-52H airframe. Since the time between initial installation of a new COTS engine and first engine removal exceeds the remaining life of the B-52H airframe, depot costs go to zero and the Air Force will experience a reduction in TOA outlay of $4.46 Billion.

In addition to the 87 engines removed annually for depot maintenance, about 70 engines each year undergo field maintenance. The average cost for each engine is $462,400 each, for a total annual cost of $32 Million per year for field maintenance. Assuming no real cost increase, no increase in engines undergoing maintenance and 3.9 percent discount rate, this totals $2.34 Billion over the remaining life of the B-52H airframe. Boeing estimates the total annual field maintenance for the new engines will cost to the Air Force $13 Million, or $1.68 Billion through the remaining life of the airframe. This is a reduction in Air Force TOA outlay of about $0.66 Billion.

Savings are summarized in the two tables below. Table 1 summarizes the estimated one year of TOA impact in current year dollars for the three O&M accounts affected by re-engining after all aircraft are re-engined. Table 2 summarizes the estimated cumulative lifetime TOA impact using figures from Table 1 and applying a discount factor of 3.9 percent. Lifetime TOA estimates shown in Table 2 assume that savings streams that make up the totals will be phased in during 2007 to 2012 according to the production schedule shown in Figure 2 below. For example, savings from the first aircraft do not appear until 2007, the first full year following acceptance of the first aircraft. As a result, multiplying dollars from Table 1 by the program lifetime will not produce the totals shown in Table 2.

	Current Outlay	Outlay After Re-Engining	TOA Reduction
Fuel Purchase	87.4	55.6	31.8
Depot Maintenance	61.8	0	61.8
Field Maintenance	32	13	19
Total	181.2	68.6	112.6

Table 1: Estimated Single Year Change in Direct O&M Outlay
(Figures in millions dollars, current dollars)

	Current Outlay	Outlay After Re-Engining	TOA Reduction
Fuel Purchase	6,308	4,490	1,818
Depot Maintenance	4,459	0	4,459
Field Maintenance	2,337	1,680	657
Total	13,104	6,170	6,934

Table 2: Estimated Total Lifetime Change in Direct O&M Outlays
(Figures in millions dollars, current dollars)

Estimated program costs and timelines are summarized in Figure 2. This assumes the $3 Million Boeing study to develop the program is funded early in FY03. The figures above the "Production" line indicate the number of aircraft modified in each year, for a total of 76.

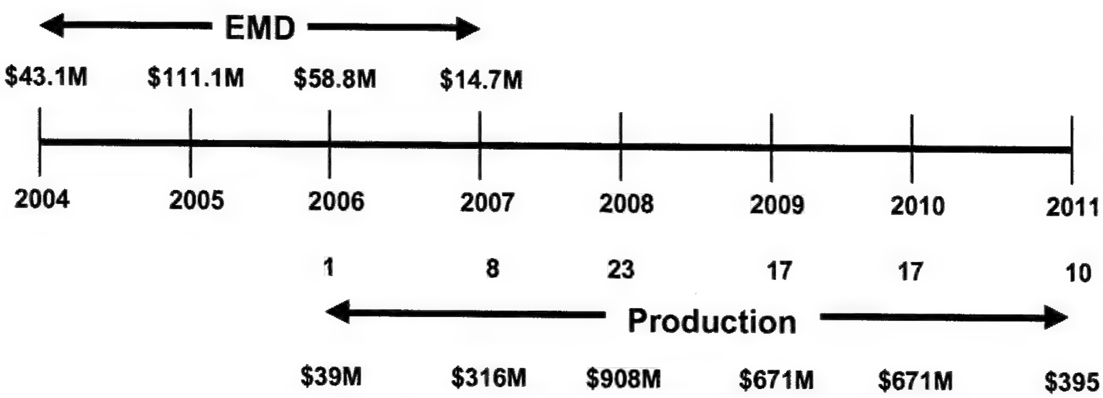


Figure 2: Estimated Program Schedule and Cost

While firm program costs are not available, the task force examined previous IDA studies that estimated program costs and consulted with the private sector regarding engine costs to develop an estimate for the purpose of this study. This led to an estimated total program cost of $3 to $3.5 Billion, assuming traditional acquisition using appropriated funds. Based on this, re-engining provides a total positive TOA impact of approximately $3.5 Billion.

Another option presented in Section VIII, Energy Savings Performance Contracting (ESPC), offers the possibility of using private funds to finance the program, with repayment from the O&M savings stream. While this results in higher total program cost, it avoids the need to use TOA to fund this program, addressing affordability concerns raised by the Air Force in earlier assessments. However, the payback period increases. Figure 3 provides Boeing's estimate of the impact on payback period of using ESPC. The O&M savings available to repay the ESPC contract would begin modestly in FY08 with about $1.75 Million, and grow to over $400 Million by the end of the airframe life.

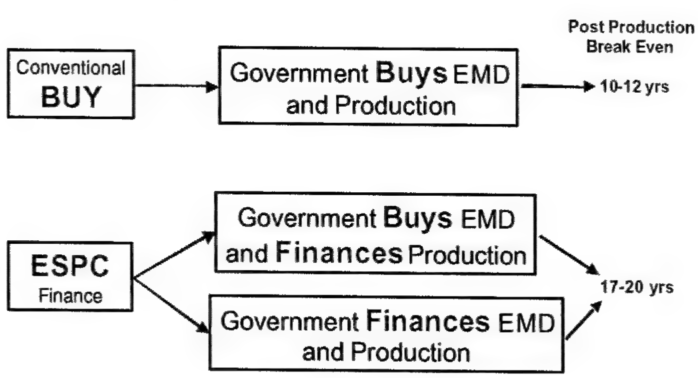


Figure 3: Impact of ESPC on Payback Period

III. The Risk of Premature Retirement

There are a number of factors that indicate whether the B-52H would be vulnerable to premature retirement. The key factors include adequate remaining airframe life, no excess of inventory, availability rates, and operationally capable now and into the future. Assessing operational capability is a complicated undertaking because the outcome is scenario dependent. The task becomes more complicated when projecting into the future. Some of the key issues to consider include suitability to current and future missions, flexibility of weapons carriage, in-commission rates, and flexibility to adapt to changing mission requirements.

III.a – Airframe Life

The B-52A Stratofortress first flew in 1954, and during the following 8 years a total of 744 B-52s, all models, were built. The B-52H began projecting global airpower with a nonstop round-the-world flight of three aircraft in January 1957. The Boeing Company delivered the first of 102 B-52H models to SAC's 379th Bomb Wing at Wurtsmith Air Force Base, Michigan in May 1961, and the last in October 1962. Each copy cost $9 million.

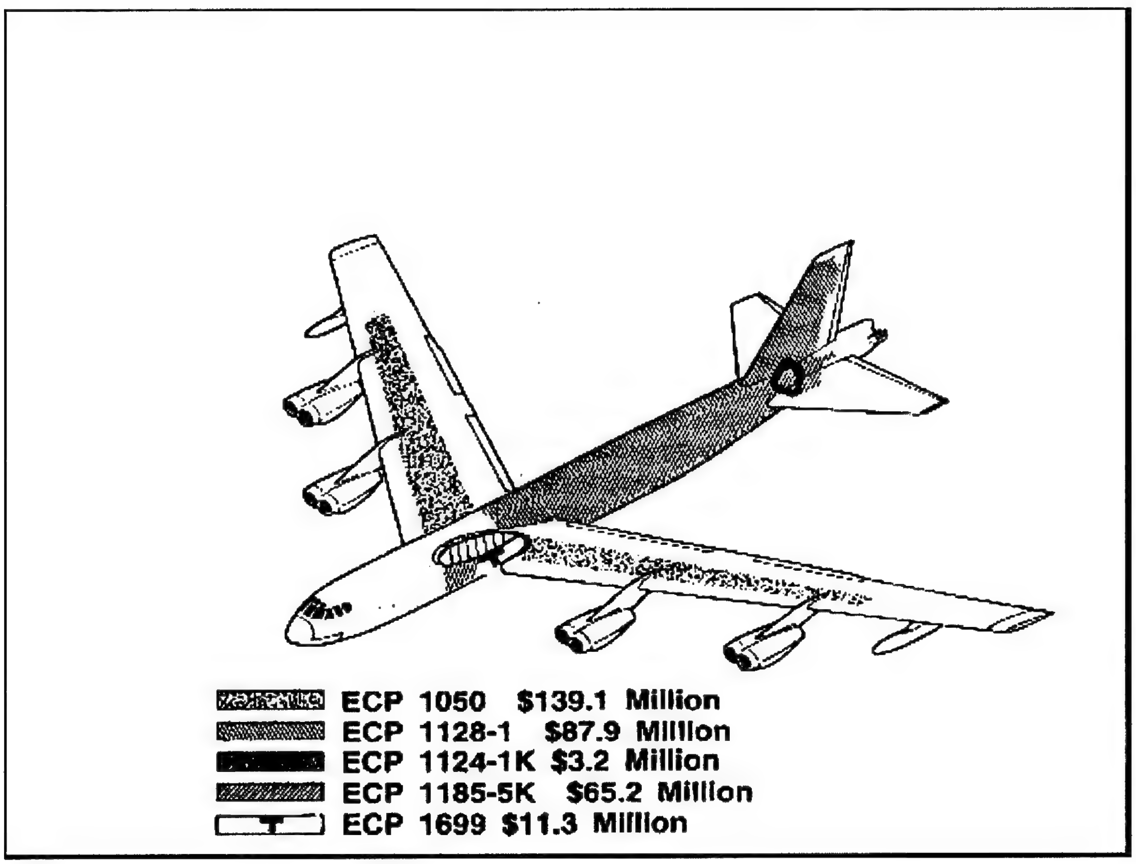


Figure 4: B-52H G/H Structural Improvements

The B-52H was designed as high altitude aircraft, but was adapted to low level tactical maneuvers in 1960's. A number of structural improvements were made during the 1960s and 1970s to equip it to fly the more demanding low-level mission and to address other structural issues. Figure 4 shows the $306 million investment between 1963 and 1979.

The airframe life for the current fleet is estimated to be between 32,500 and 37,500 hours, depending on the usage history of the individual aircraft. The estimate is based upon scaling measurements from a full-scale test structure using assumed mission profiles along with historical and projected usage information. The upper wing surface is expected to be the life-limiting structural member, as shown in Figure 5. The task force consulted with the B-52H System Program Office and Boeing to reaffirm this estimate.

As of 1999 the average airframe had 14,700 flight hours. Boeing believes with high confidence that the average number of flight hours left is 17,800, at a minimum. The "oldest" B-52H is at about 21,000 hours and only experiences about 380 flight hours per year. Figure 7 shows the economic life of the B-52H fleet, with the projected remaining average life.

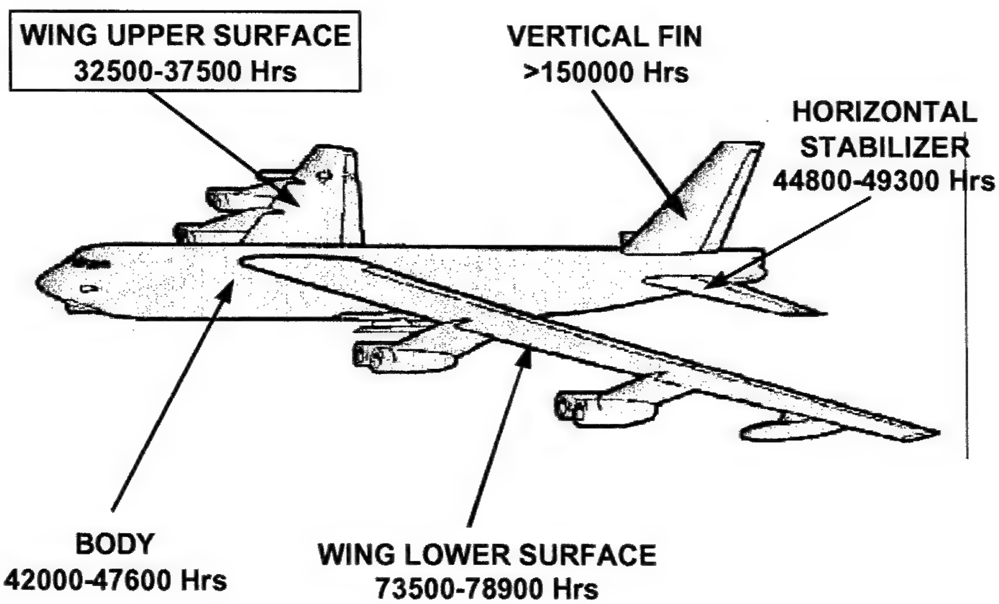


Figure 5: Economic Life of B-52H Structure

Measured by flying hours and cycles, it is now just over halfway through the economic lifetime of its limiting structural member, the upper wing surface. Current structural analyses indicate with a high degree of certainty that the B-52H is capable of remaining in the inventory until the 2040 timeframe, assuming it flies a low-level mission. However, the B-52H is no longer used for a low-level mission and the estimate of 2037 may be conservative.

To put this in perspective, commercial aircraft flying domestic routes experience about 3,000 flight hours per year and 2,500 cycles.[4] A commercial aircraft flying international routes experiences about 4,500 flying hours per year, and about 1,000 cycles. In both cases their mission capable rate is about 99 percent. At these rates the B-52H would have only been about a 10-year aircraft, based on the life limit of the B-52H Upper wing surface. However, with the B-52H annual utilization rate only one tenth that of commercial rates, a B-52H should last about 10 times as long, or roughly 100 years. Figure 7 compares B-52H usage with a number of wide body commercial jets in service today.

A number of Boeing 747s flying today have 30,000 to 40,000 hours on their airframes. These older aircraft have only about a 50 percent availability (mission capable) rate, and are beginning to cause maintenance problems, which are growing quickly. Relatively speaking, the B-52H is a young airframe. Figure 8 compares the relative age of the B-52H to commercial aircraft in terms of number of flight hours and cycles.

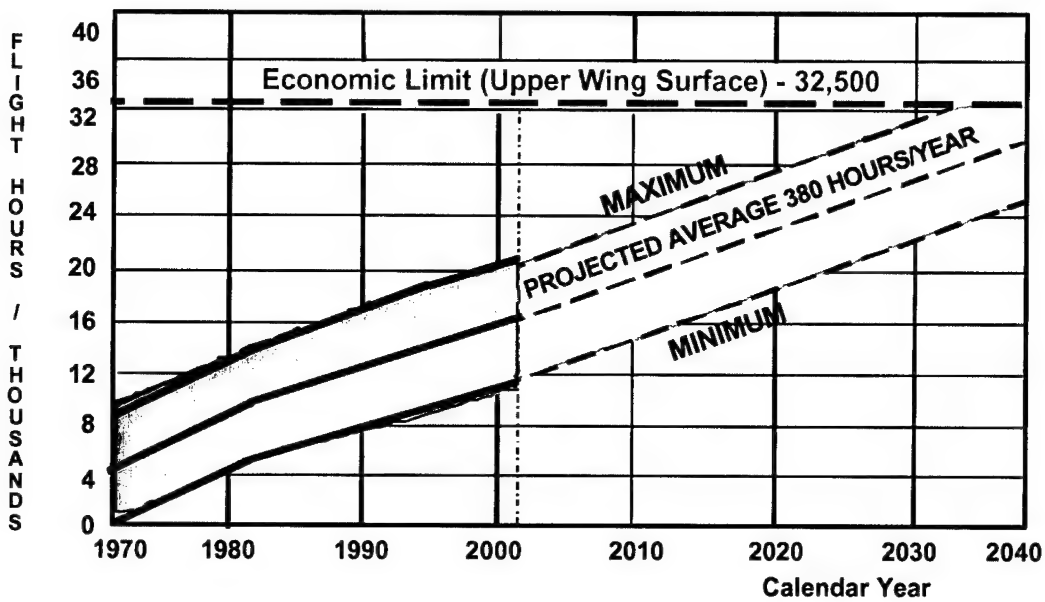


Figure 6: Economic Upper Wing Limit Based on Low-Level ConOps

OC-ALC performed a durability assessment on the wing upper surface to determine the impact of re-engining on the projected economic lifetime of the airframe. They assumed:

- Weight Increase of 400 Pounds per Strut/Pod
- Included low level scenario

[4] A cycle is a take-off and a landing.

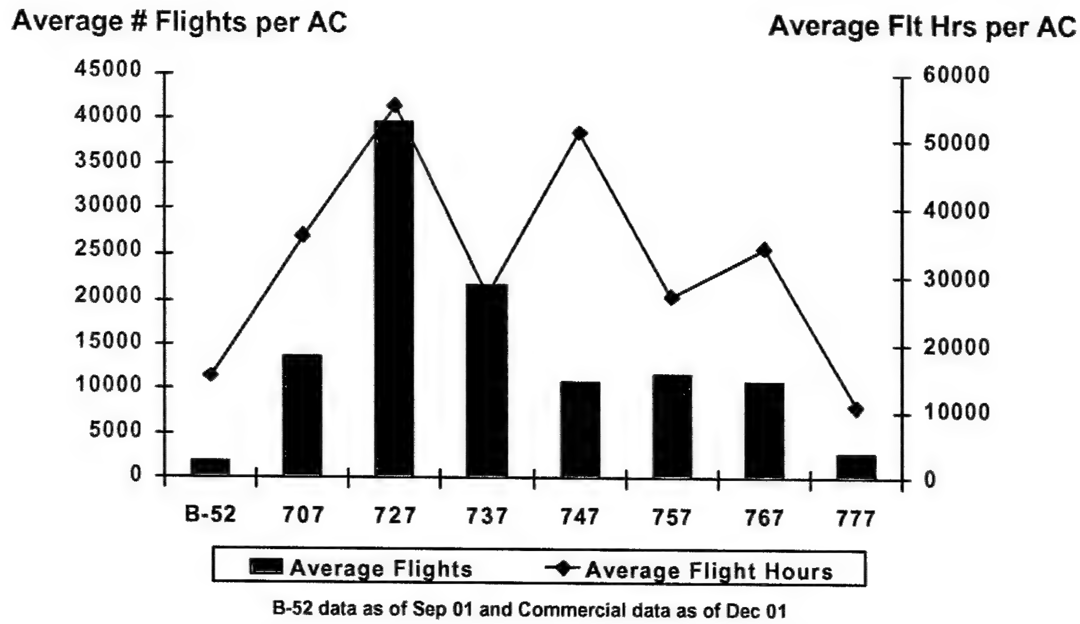


Figure 7: B-52H Usage - Comparison With Commercial Fleet

The results showed a negligible increase in the crack growth rate. With the wing down bending moment increase due to the higher engine weight, the impact was a 1.41 percent projected service life reduction at the outboard pylon and a 0.88 percent projected service life reduction at the inboard pylon. This would lower the "Lower Bound Economic Upper Wing Life" from 32,500 to 32,042 hours. Re-engining will not degrade the structure.[5]

Bomber service life is based on the point where it becomes more economical to replace aircraft than to continue structural modifications and repair. Current projections show all 3 bombers should be structurally sound for the next four decades. Next Generation Bomber Study (NGBS) demonstrated aggressive modernization of bomber fleet will provide new bomber equivalent capability at significantly less cost.

The task force is satisfied with the structural analyses conducted by the OC-ALC that predicts an economic lifetime until 2037. However, the current life estimates assume continuation of the more structurally stressful low-level mission, which has not been experienced by the airframes nor practiced by aircrews for many years. Specifically, the low-level mission is experienced by only 10 airframes assigned to the test squadron at Edwards AFB, which are not assigned to combat roles. However, while removal of the low-level mission may extend the life of other parts of the airframe, Boeing does not believe it impacts the life-limiting upper wing surface. According to the information the task force was able to obtain, neither Boeing nor the B-52H Systems Program Office have conducted studies to determine the impact on airframe life of eliminating the low-

[5] OC-ALC /LH (B-52H System Program Office) briefing to the task force, July 15, 2002, and subsequent correspondence

level mission, and were unable able to offer any estimates. While Boeing indicated that removing the low-level mission has no impact on the life-limiting part, they provided no data to support their statement. The impact of eliminating the low-level mission from future lifetime estimates was indeterminable within the scope of the task force study.

The B-52Hs emerging profile as a long range conventional delivery platform such as its role in Afghanistan, new employment concepts such as long loiter with high density standoff precision munitions or perhaps an anti-ballistic missile platform, would be less stressful than current profiles. The task force recommends the SPO and Boeing investigate the impact of eliminating low-level missions on projections of future airframe economic lifetime.

III.b – Inventory

Previous studies assumed that the USAF bomber fleet would remain constant at 208 total assigned aircraft and cited the economic loss from premature retirement of aircraft to be a significant program risk.

Since those studies, the Air Force has decided to retire 33 B-1s and 17 B-52Hs, reducing the current fleet of 208 bombers (93 B-1s, 21 B-2s, 94 B-52Hs) to 157, as shown in Table 3 below. Of these bombers, only 96 will be combat coded, with the rest used for backup and other purposes. The B-52H and B-2 still retain a conventional and a nuclear mission, while the B-1 is roled for the conventional mission only.

Aircraft	Combat Coded	Training	Test	BAI/AR	Total
B-1	36	19	4	4	60
B-2	16	0	1	4	21
B-52H	44	12	2	18	76
Total	96	28	7	26	157

Table 3: Air Force Planned Bomber Force Structure

The task force concluded that the Air Force planned bomber force structure represents deminimis bomber numbers for the United States to own, and makes it unlikely these numbers would decline any further in the absence of introduction of a new long range strike platform.

And currently, the Air Force does not envision a new long range strike platform becoming operational until 2037. This coincides with the currently projected end of the B-52H economic service life. There are a number of efforts ongoing within the Air Force to determine the future timeline and replacement strategy for the current bomber force.

An Air Force white paper on long-range bombers dated 1999 is currently being revised as a result of DoD's transformation plans and recent operational experiences.

SECAF directed an updated Long-Range Strike Aircraft (LRSA) White Paper in October 2001 that includes the following areas:

- Long-Range Bomber Force Structure Plans
- Modernization
- Capabilities
- Concept of Operations
- Replacement Timeline

The purpose of the LRSA White Paper is to provide a "snapshot" update and serve as a basis for a bomber roadmap currently in development by Air Combat Command. It calls for an acquisition program to begin in 2019 to support an operational system in 2037.

In addition, the Air Force is conducting a Long-Range Strike Aircraft X (LRSA-X) study to examine bomber replacement timelines. It is unclear whether once fielded that the need for current bombers will diminish. LRSA-X envisions the next generation of long-range strike platforms and weapons will rely on revolutionary technology. The Air Force is actively engaged in analysis of the path to retain the best attributes of our current platforms. These efforts will be closely connected to AF concept of operations (CONOPs) for the Global Strike Task Force and other CONOPs under development. The study goal is to start an acquisition program in the 2012 to 2015 timeframe. This appears to be at odds with current airframe lifetime projections for the current bomber force.

This is earlier than the 2019 date stated the 1999 white paper, which the Air Force states is necessary in order to support an operational system in 2037. While the 1999 white paper called for the existing bomber force structure to fall below what the Air Force considered "acceptable levels", the press has reported that none of these tentative program dates are definitive.

The Air Force has also noted in the press that the 2037 service-life date represents the best current estimate "based on current and possible future mission profiles," but that recent changes in bomber force structure and new operational concepts "may have invalidated previous service life conclusions and require new analysis."

III.c – Operationally Capable

The B-52H is highly operationally capable, and will continue to be so into the foreseeable future. It has the most flexible carriage capability of any of the three bombers and is the only Conventional Air Launched Cruise Missile (CALCM) capable platform. It's flexibility to adapt to new missions and value in the war on terrorism was clearly demonstrated during OEF.

The task force reviewed the seven mission types in which the Air Force expects its long-range bombers to be effective, and the B-52Hs ability to fulfill those missions. A summary follows.

- <u>Strategic Attack</u> – key enabler.
- <u>Interdiction</u> - well suited for attacking interdiction targets.

- Offensive Counter Air (OCA) Operations - may be the platform of choice against air bases beyond the range of fighter aircraft.
- Suppression of Enemy Air Defenses-Conventional (SEAD-C) - B-52H well suited.
- Joint Maritime Operations (Air) – only bomber capable of carrying AGM-84 Harpoon anti-surface munitions; well suited to other aspects due to loiter capability.
- Close Air Support (CAS) – effectiveness proven during OEF.
- Special Operations – capable with long range munitions.

The Air Force does not consider the 3 current bombers as interchangeable. Each has a specific mission area filling a particular combat niche. However, when considering modernization investments, it is useful to compare the relative operational capabilities of similar platforms. The relative importance of performance measures in determining effectiveness of the B-1 and B-52H is mission specific. There is little difference in the capabilities of the B-1 and B–52H to perform most assigned bomber missions. Further, the B-52H is more capable than the B-1 for a number of missions and can conduct niche missions for which the B-1 is unsuitable. For example, the B-52H is somewhat less vulnerable to Anti-Aircraft Artillery (AAA) than the B-1; the B-52H has a longer range, higher ceiling and slightly higher cruise airspeed. The B-52H also has a greater sustained turn rate than the B-1 at comparable weights and altitudes. Using military settings, the B-52H has a higher climb rate, but using afterburner the B-1 has a much greater climb rate. The B-52H also has generally better take-off performance, requiring 1,000 to 2,000 feet less ground roll for a given takeoff weight. The B-52H also has a shorter landing roll at comparable weights; with the difference increasing as landing weights increase. Both systems are vulnerable to current air defenses and must rely on standoff munitions to ensure survivability. Table 4 below is a current capability payload comparison for the B-1, B-2, and B-52H.[6]

Logistically, the Mission Readiness Spares Package (MRSP) for the B-1 is slightly lighter than that for the B-52H, but the B-52H kit provides resources for 30 days of deployment while the B-1 kit provides only for 14 days. In addition, the B-1 MRSP includes a significant amount of "outsized cargo", while the B-52H has no such cargo. Outsized cargo requires a C-5 or C-17 aircraft.

In each of the mission types described above, the re-engining benefits of increased range, increased loiter and reduced tanker requirements contribute to the effectiveness of the B-52H.

[6] Multiple Sources: IDA Paper P-3367, "Analysis of the Capabilities of the B-1B and B-52H Heavy Bombers," February 1998; HQ USAF, USAF Long-Range Strike Aircraft White Paper, November 2001; ACC Bomber Roadmap, 2002

Munitions	B-1	B-2	B-52H
Direct Attack-Conventional			
Unguided Weapons			
MK-82 500-pound General Purpose	84	80	45
M-117 750-pound Blast		36	45
MK-84 2000-pound General Purpose	24[7]	16	18
M129E1/E2 – Leaflet Dispenser			yes
CBU-87/89/97 – Cluster Bombs	30/30/30	34/34/34	24/24/0
Guided Weapons			
GBU-10/12 Laser Guided Bomb			10[8]
GBU-31 – JDAM (2000-pound)	24	16	12
GBU-37 GAM		8	
GBU-38 JDAM (500-pound)	*48*[9]	*80*	*16*[4]
EGBU-28 LGB		8	
CBU-103/104/105 WCMD	30	34[4]	16
WCMD-ER	*30?*	*34?*[4]	*16?*
Small Diameter Bomb	*96-288*	*64-192*	*48-144*
Direct Attack Nuclear			
B-61 & B-83	non-nuclear	16	8
B-61-11	non-nuclear	16	
Standoff - Conventional			
AGM-158 - JASSM	*24*	*16*	*12*
CALCM			20
AGM-154 - JSOW	12	16	12
AGM-142 – Have Nap			3-4
AGM-84D - Harpoon			8
Standoff - Nuclear			
ALCM			20
ACM			12
Mines			
Mk 56 Moored Mine			20
Mk 62 Quickstrike 500-pound Mine	84	80	45
Mk63 Quickstrike 1000-pound Mine			18
Mk-65 Quickstrike 2000-pound Mine	8		18
Other Factors			
Absolute Maximum Internal Payload	75,000 lbs	44,000 lbs	100,000 lbs
Absolute Maximum External Payload	0	0	50,000 lbs
Total Maximum Structural Payload	75,000 lbs	44,000 lbs	150,000 lbs
Internal Bay Size	15' x 6.7' (3)	20.8' x 6.8' (2)	26.5' x 6' (1)
Illustrative Internal Payload[10]	50,400 lbs	33,600 lbs	25,200 lbs
Illustrative External Payload[11]			39,000 lbs
External Hard Points	0 (removed)	0	2

Table 4: Bomber Payload Comparison – Current Capability

[7] Not effective – timing of release due to launcher configuration renders dumb bombs ineffective.
[8] No self-designation capability.
[9] Not currently planned
[10] Maximum JDAM load (2,100 lbs each)
[11] Maximum 12 external CALCM (3,200 lbs each) (12 of 20 carried external)

To be effective in these roles, according to the Air Force's Long Range Strike Aircraft White Paper (LRSAWP) the most important factors driving future bomber requirements are:

- Increased lethality results from the munitions carried and the electronic suites installed, but the first factor listed in the LRSAWP is longer range, one of the primary benefits of re-engining.
- Enhanced survivability is related to improved defensive systems for survival against future threats. The B-52H's large payload makes it particularly suitable for use of decoys, but re-engining does not improve this capability. Because the new modern engines run hotter than the TF33-103s, re-engining could increase the B-52H IR signature.
- Improved supportability includes reduced cost of ownership, and improved aircraft availability and mission capable (MC) rates. Re-engining supports all three of these objectives, particularly reduced ownership costs.
- Responsiveness includes minimizing sortie turn times, maximizing carriage of different weapon types on the same mission and reducing logistics trails for deployment and sustainment of combat operations. Re-engining reduces sortie turn times for certain types of missions and reduces logistics tail for deployment. The B-52H already has the most flexible weapons carriage.

These long-term needs support the tenets of Joint Vision 2020, Air Force CONOPs, and Air Force Strategic Plans. They also mirror long-term capabilities required in the FY02 Global Attack Mission Area Plan (MAP). Re-engining also supports other specific long-term bomber objectives stated in the Air LRSAWP, such as those listed below:

- Replace high failure aircraft components with modern, highly reliable systems.
- Replace aircraft parts and structures that reached the end of their operational life.
- Improve aircraft systems commonality and maintenance practices.
- Reduce main operating base (MOB) and forward operating location (FOL) logistics footprint.
- Upgrade or replace aging support equipment and base support facilities.
- Develop maintenance practices that reduce sortie generation times.

The Air Force vision is to be able to place about 100 combat capable aircraft in theater in 48 hours. This is not a requirement and is not supported by the Air Force program, but only a vision. The Air Force's desire is to have the major combat aircraft of an AEF in theater in 48 hours. Currently, the Air Force is capable of

doing this on paper in 72 hours and in practice exercises in 96 hours. Ultimately, to become a reality, this must become part of the Air Force program.

Nevertheless, the Air Force is advertising to combatant commanders that they can have an AEF capable of striking up to 400 targets per day covering an area about half the size of Texas in 48 hours with no previous presence. It was unclear to the task force that this is logistically supportable. However, the task force observed that the ability of a B-52H to reach AEF deployed locations without refueling would contribute to this capability. An unrefueled re-engined B-52H would be capable of striking any target worldwide from CONUS with only one air refueling, and many locations without any refueling.

In terms of actual operations, throughout the 1990s, the B-52H proved its value in Operation Desert Storm over Iraq and Kuwait, Operation Allied Force over Kosovo, and most recently in Operation Enduring Freedom over Afghanistan. The Gulf War involved the longest strike mission in the history of aerial warfare when B-52Hs took off from Barksdale Air Force Base, La., launched conventional air launched cruise missiles and returned to Barksdale - a 35-hour, non-stop combat mission. In all 3 operations, the B-52H successfully struck wide-area troop concentrations, fixed installations and bunkers.

None of the 3 Air Force assessments of the costs and benefits of re-engining the B-52H considered the impact on tanker requirements, the value of purchasing tanker capacity in this way, or of the value of the operational benefits of extended range or increased loiter time. This task force and the 2001 DSB task force on "More Capable Warfighting Through Reduced Fuel Burden" valued the tanker reductions, but were unable to find a methodology that could place a financial value on value of the operational benefits. The task force recommends OSD investigate the potential of including the value of improvements in operational capabilities in cost-benefit analyses as a way to strengthen the analytical basis for decision-making within DoD.

The B-52H serves in both a nuclear and conventional role. Its can also perform a wide range of specialized missions, such as CAS, launch platform (reconnaissance drones, LEO satellites), UCAV carriage, BMDO interceptor and can carry a small offensive laser. Modifications to enable it to perform an electronic attack mission are also under consideration.

Historically, the capability of a platform has been measured by how many it would take to kill a target, but today it is measured by how many targets it can kill. For example, in the 1940s, planners estimated it required about 650 bombs to kill a target. By the 1970s, they estimated bout 175 bombs. By 2000, precision munitions enable a single bomber to potentially kill about 24 targets, and the small diameter bomb is expected to extend that even further to possibly over 50 targets per aircraft. As a result, the capabilities to strike more precisely and autonomously from longer stand off distances have had a radical impact on the requirements for platforms. The capability of the platform itself to penetrate and maneuver in close proximity to

enemy air defenses has become less important. The capabilities of munitions are displacing the need for capabilities of the platform.

The B-52H is credited with delivering over 30 percent of the total Desert Storm munitions tonnage, while comprising only 3 percent of the aircraft deployed. This was the B-52G model, which was not as capable as the H model in terms of munitions carried or unrefueled range. According to the Gulf War Air Power Survey (GWAPS), the A-10, F-117 and F-111 destroyed most of the targets.

As was demonstrated in Operation Enduring Freedom, the line between traditional bomber and fighter missions are becoming less well defined. In OEF, the B-1, B-2 and B-52H functioned as long-range strike platforms.

III.d – Availability

The B-52H also has the highest in-commission rate of any of the three bomber platforms, as shown in Figure 8. According to OC-ALC/LH, engines are not a high driver in terms of NMC (not mission capable) hours for the B-52H - only around 7%. Other non-engine and non-airframe maintenance issues are higher in terms of their contribution to NMC rate. The average depot flow time for the TF33-103 engine is around 74 days. Assuming perfect engines, the MC rate would increase only about 2 percent, from just over 78 percent to just over 80 percent.

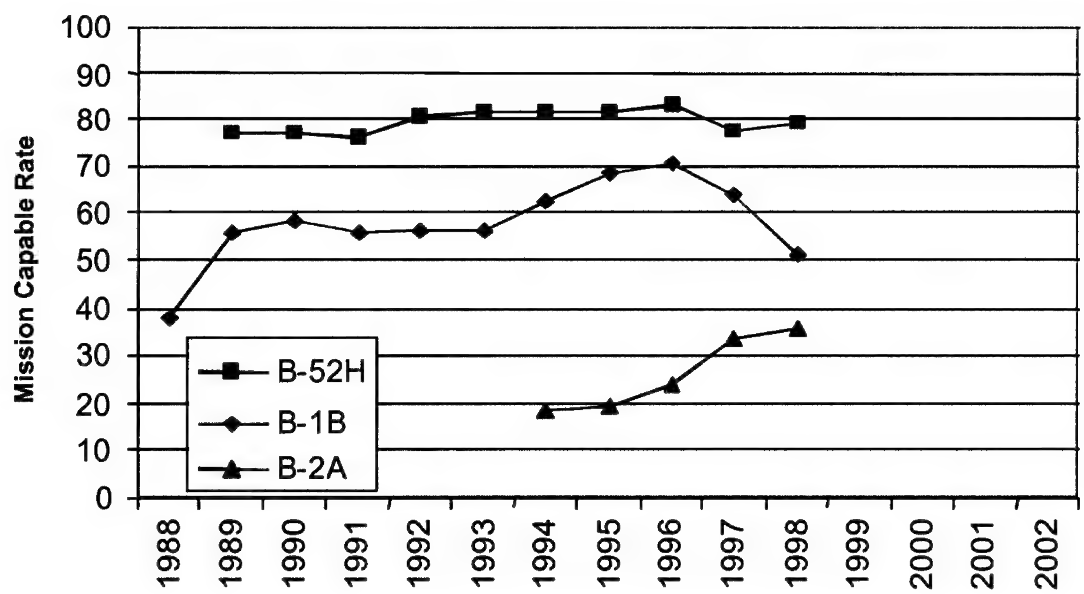


Figure 8: Bomber Mission Capable Rates

Further illustrating the reliability of the B-52H is the fact that only one bomber-centric item was listed on the Air Force-wide FY-03 unfunded priorities list presented to Congress. Priority No. 5 on the FY-03 "wish list" is titled "emerging deficiencies impacting aircraft mission-capable (MC) rates." The Air Force explained in the wish list that unforeseen maintenance requirements will force it to ground some B-1s, B-2s and F-15s unless $163.3 million becomes available in early FY-03.[12] A lack of funding for needed upgrades was one of the principle reasons the Air Force decided last year to retire one-third of the B-1 bomber fleet. The Air Force intends to pump the savings generated by retiring B-1s and consolidating operations at two bases instead of five back into upgrades.[13]

Considering there is no bomber aircraft currently in development; the substantial capability of the B-52H to accomplish its assigned missions; that the USAF chose to retire more than twice as many B-1 airframes as B-52H airframes; and the extremely low number of available PAA bombers remaining, the task force concludes that further significant reductions in the B-52H fleet is unlikely for the foreseeable future.

III.e – Future Utilization Concepts

The Air Force is currently considering modifying the B-52H for an electronic countermeasure mission. Characteristics that would make the B-52H highly capable for this mission include range, loiter and payload. With re-engining, the range of the B-52H begins to result in a mission length that approximately coincides with maximum crew day. Utilizing excess space in the airframe to accommodate an additional crew would allow virtually unlimited loiter times and make maximum utilization with minimum tanker demand.

During OEF, Gen Franks used the B-52H for close air support, providing what essentially amounted to field artillery over a very wide area. This is a mission never envisioned for the B-52H, but which was enabled by precision standoff munitions. Re-engining would have allowed bombers to remain aloft for a greater amount of time, reducing the B-52H cycles and the number of tanker sorties needed in support of the B-52H missions.

The B-52H is also capable of greater effectiveness as munitions achieve greater precision, standoff and mission versatility. National Missile Defense appears to be an emerging mission appropriate for the B-52H as well.

[12] "B-2 hot trailing edge damage requires removal of components critical to maintaining low-observable characteristics," the list stated. Six stealth bombers are already "degraded and en route to becoming non-flyable," it added. Meanwhile, "at least" three B-1s were projected be grounded in October 2002 for "excessive metal-to-metal rubbing.

[13] New Bomber Road Map Leaves Open The Possibility Of A New Strike Aircraft Defense Alert, Aug. 22, 2002

IV. Operational Impacts of Re-Engining

The task force examined recent operations to determine how a re-engined B-52H would have performed. Because the recent operational missions have taken place in the middle-east and flown predominantly from Diego Garcia, the 46 percent increase in unrefueled range had a significant impact on the capability of the B-52H to conduct these missions.

IV.a – Range, Reach and Loiter

Range is the maximum distance an unrefuleled aircraft can fly under specific conditions and return to base. Reach is defined as distance at which an aircraft can strike a target, or the aircraft range plus the range of the munitions it carries. Loiter is defined as the amount of time an aircraft can remain aloft over its target area. These three factors, along with payload, are variables that can be traded against each other to provide an optimum configuration for a given mission.

The current unrefueled range of the B-52H is 5,088 nautical miles, assuming maximum takeoff gross weight of 488,000 lbs, maximum cruise range, weapons are retained, and allowing for one hour of reserve fuel. Under these same conditions, the unrefueled range of a re-engined B-52H is expected to increase to 7,420 nautical miles, or about a 46 percent increase. Because the operational value of this increase is scenario dependent, the task force evaluated tasks the B-52H has recently been called upon to perform.

During Operation Enduring Freedom, the B-52H flew daily from Diego Garcia to Kabul. Figure 9 compares the unrefueled range and loiter time available to the current and re-engined B-52H. Time on station is the vertical axis and mission radius is the horizontal axis. These notional mission profiles assume weapons loadout of 12 JDAMs and 27 Mk 82s, maximum takeoff weight, and a two-hour fuel reserve, as required for overwater missions.

Figure 9 shows that the current B-52H cannot fly roundtrip to either Kabul or Baghdad from Diego Garcia without refueling. However, a re-engined B-52H can fly to either Kabul or Baghdad without refueling. It would also have approximately 4.7 hours loiter time over Kabul to execute its mission, and about three hours over Baghdad to execute its mission. Since Diego Garcia is a key strategic airfield and ramp space is limited, reducing the number of tanker aircraft needed at that location also carries other operational benefits.

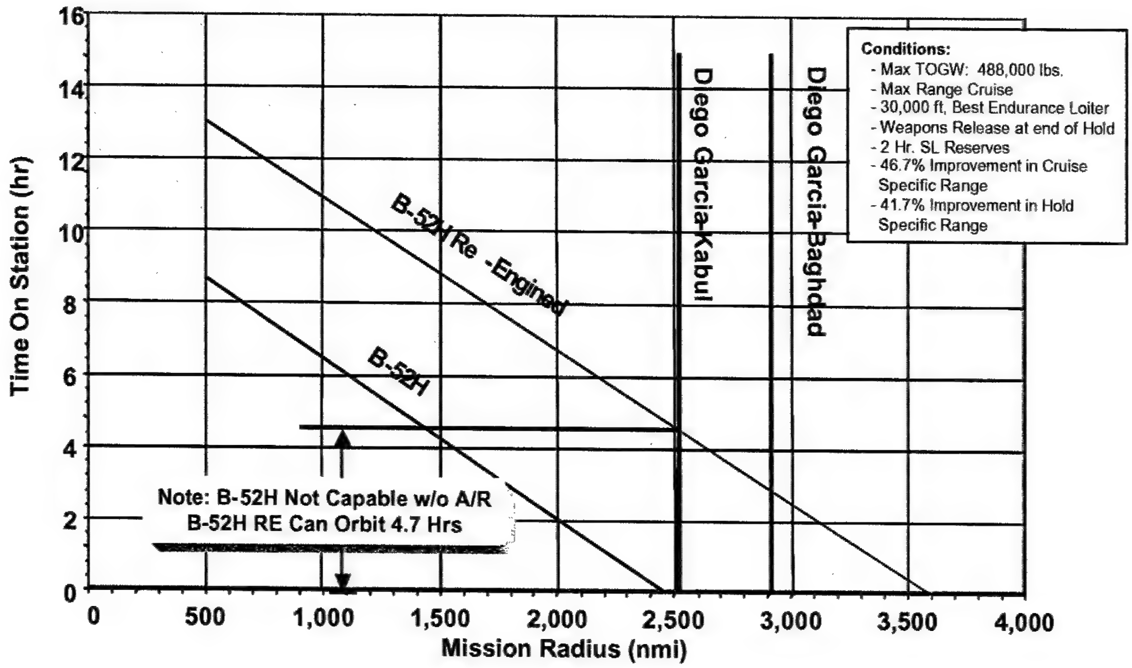


Figure 9: Unrefueled Diego Garcia to Kabul and Baghdad

Early during the study, the task force had an opportunity to specify an analysis of the B-52H missions that supported Operation Enduring Freedom from October 24, 2001 through November 11, 2001. With the Boeing numbers not yet available, the task force asked for an analysis of the impact on tanker demand if the B-52H had 25 percent greater range. The analysis revealed that a B-52H with 25 percent greater range would have required 66 percent fewer tanker sorties to complete the same missions. The task force was unable to have the analysis redone using 46 percent increase in B-52H unrefueled range. This is because of the level of effort needed to conduct the analysis. Unlike the SIOP where tankers are dedicated to supporting B-52Hs, it is more difficult in this case to make the translation from reduced fuel on-load demand to reduced number of sorties to reduced tail requirements. This is because the tankers were supporting other aircraft as well as the B-52Hs.

However, the OEF analysis showed that based on a 25 percent unrefueled range improvement, 33 percent fewer tanker aircraft would have been required at Diego-Garcia to support OEF. These tankers would have been available for deployment elsewhere, and would have opened scarce ramp space at Diego Garcia. Tanker availability was often a problem that constrained planning and executing OEF missions.

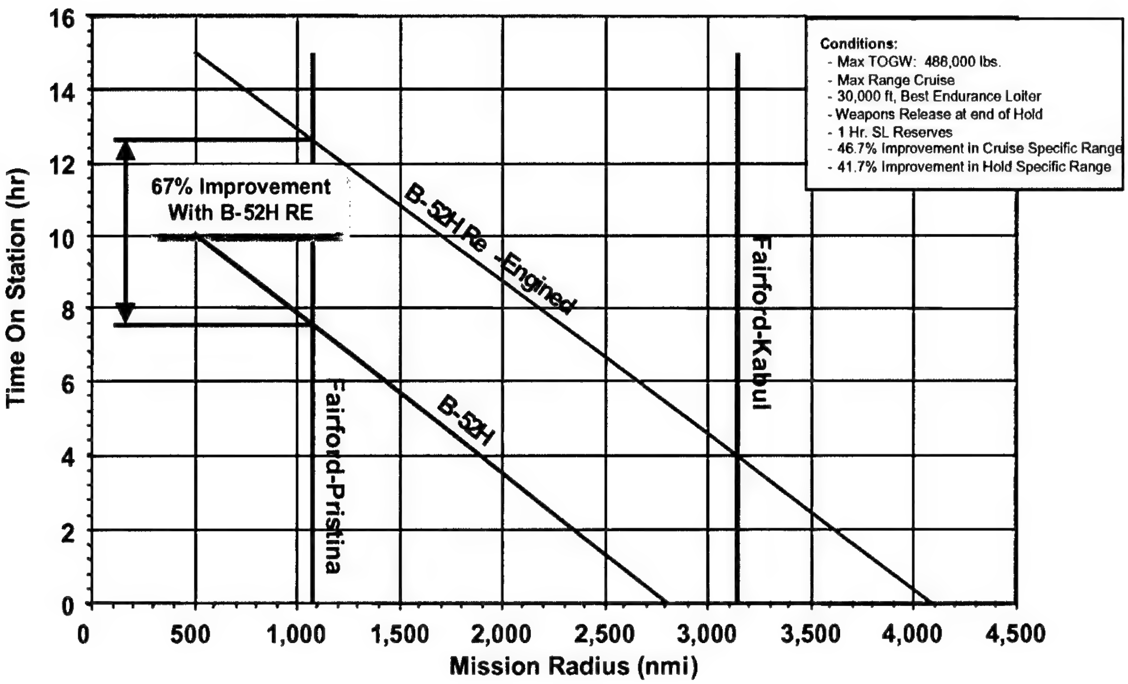


Figure 10: Unrefueled RAF Fairford to Pristina and Kabul

The other primary overseas B-52H base is RAF Fairford. Figure 10 compares the unrefueled range and loiter time available to the current and re-engined B-52H from RAF Fairford to Pristina and Kabul. These notional mission profiles assume weapons loadout of 12 JDAMs and 27 Mk 82s, maximum takeoff weight, and a one-hour fuel reserve, as required for overland missions.

While the current B-52H can fly roundtrip from RAF Fairford to Pristina unrefuled, re-engining increases time on station by 67 percent. The current B-52H cannot fly roundtrip to Kabul from RAF Fairford without refueling. However, a re-engined B-52H can fly from RAF Fairford to Kabul and have about 4 hours of loiter time to execute its missions without refueling.

Moving from the most current to the legacy missions, the B-52H remains a key element of the strategic triad. Using the Boeing estimate of 46 percent unrefueled range increase, a re-engined B-52H could strike anywhere on earth using CALCMs with only one refueling, with a large portion of the earth covered without any refueling. For example, a CALCM attack from Barksdale to Baghdad would require one refueling sortie instead of two, as shown in Figure 11. This assumes maximum take off gross weight of 488,000 lbs, a single B-52H, no wind, maximum cruise range, 1 hour fuel reserve at mission end, 20 CALCM loadout, and weapons launch at radius distance. The total fuel burn would be 32.7 percent less, and total fuel onload would be 58.7 percent less. The existing B-52H would require 2 refuelings out of Moron, and a re-engined B-52H would require one out of Incirlik, a 50 percent decrease.

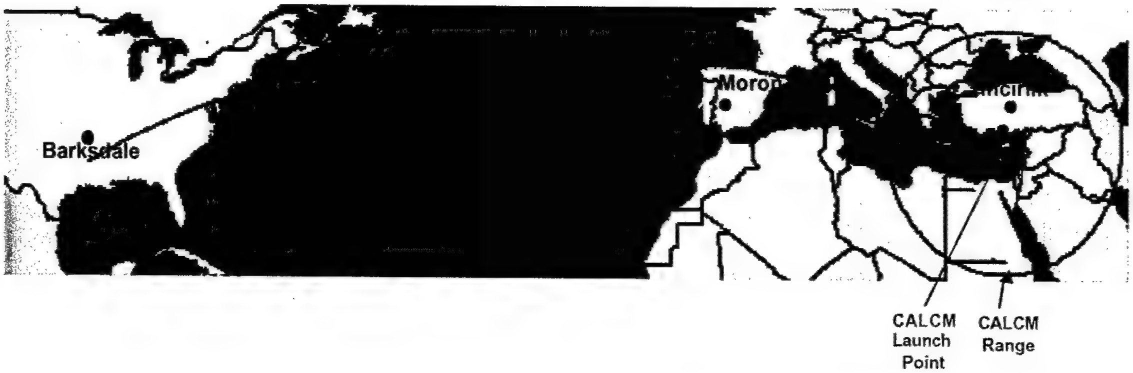


Figure 11: CALCM Attack Mission - Barksdale-Iraq-Barksdale

Bombers can strike pre-planned targets or loiter in wait for mobile or time-critical targets. Both B-1s and B-52Hs were used to accomplish these missions in Operation Allied Force. Bombers employ in two basic environments - Standoff and Direct Attack.

In a more generic context, with J-series weapons (JDAM, JSOW, and JASSM), each bomber has the ability to employ in both environments throughout the AOR. In recent operations, stealth aircraft are used initially to "kick down the door" and neutralize air defenses, to be followed with non-stealth aircraft. As munitions become more capable, the B-52H can operate with increasing effectiveness beyond the reach of enemy air defenses. Investing adequately in munitions inventories is necessary to provide platforms with these capabilities.

Standoff allows bombers to remain outside the effective range of enemy defenses, and may be the initial conflict environment due to the enemy's anti-access / area-denial capabilities, defenses, or political situation. However, penetration of enemy airspace may still be necessary, in which case aircraft with stealth characteristics are used until suppression of enemy air defenses is achieved. As a general guideline, longer-range threats (e.g., Airborne Interceptors, SA-5s, SA-10s, etc.) require longer range standoff (e.g., CALCM, JASSM). However, force packaging and effective SEAD can allow shorter-range standoff and even direct attack. Mobile targets are harder to kill with long time of flight and targeting uncertainties than fixed targets.

In Direct-Attack bombers strike targets inside enemy airspace using a combination of tactics, weapons and strike package integration. Due to the probability of encountering enemy air defenses, strike assets are usually packaged to increase survivability. Direct-attack strikes fixed, mobile, and emerging targets using off-board and on-board information.

Table 5 shows unclassified standoff ranges and typical defenses (roles) the respective weapons would likely be used against.

Standoff	Role	Bomber Carraige	Weapon	Warhead Type	Range (NM)	Inventory Objective
Long-Range	Theater Defense	B-52H	AGM-86C (CALCM)	Unitary (<1Klb)	600+	
Medium-Range	Area Defense	B-1, B-2, B-52H	AGM-158 (JASSM)	Unitary (1Klb)	200	2,400 – 3,200
Medium Range			JASSM-ER			
Short-Range	Point Defense	B-1, B-2, B-52H	AGM-154A (JSOW)	CEB	40	3,000
Short Range	Point Defense	B-1, B-52H	WCMD-ER	CEB/SFW		7,500
Short-Range	Point Defense	B-1, B-2, B-52H	Small Diameter Bomb	Unitary (.25Klb)	Classified	24,000?

Table 5. Standoff Ranges

IV.b – Other Performance Factors

There are a number of slight improvements in flight performance with re-engining. However, the task force considered these to be of negligible operational value and not major key to a re-engining decision.

Flight envelope is normally considered to be the operating altitude and speed limits in steady level flight. The maximum speed for the B-52H is Mach 0.84 or 390 knots whichever is less. The normal high altitude cruise speed based on gross weight is Mach 0.74 to 0.78. The normal low-altitude penetration airspeed is 340 knots, but can be increased to 380 knots under high-threat conditions. The normal cruise altitude at heavy gross weights is 30,000 to 35,000 feet MSL; at light gross weights the cruise altitude can be higher than 45,000 feet MSL. Stall speeds range from approximately 153 knots at 488,000 lbs down to 99 knots at 200,000 lbs.

The B-52H requires 7,600 feet to takeoff at maximum gross takeoff weight of 488,000 lbs. Re-engining is estimated to reduce this figure by 20 percent, due to an increase in thrust of about 36 thousand pounds. This will increase the number of airfields capable of physically accommodating the B-52H worldwide; however, another limiting factor is the width of the airfield. The re-engined B-52H would require a runway width of 175 feet, exceeding the 150 feet, which is more typical. The importance of this depends on many factors, including numbers and locations of airfields now B-52H capable, permission for their use, and mission requirements.

The normal cruise altitude at heavy gross weights is 30,000 to 35,000 feet MSL. At light gross weights the cruise altitude can be higher than 45,000 feet MSL. Climb rate would also improve slightly with re-engining.

IV.c – Basing

Basing at FOLs is driven by both political and operational considerations. Many potential FOLs require host nation approval. While it is difficult to predict which FOLs would be necessary to support a future contingency, examining those used in the past offer some insights. The FOLs used by B-52Hs in Desert Storm were RAF Fairford (United Kingdom), Moron (Spain), Diego-Garcia and Jeddah New (Saudi Arabia). Some of the bases used by supporting tanker aircraft during Desert Shield / Desert Storm were Zaragoza (Spain), RAF Mildenhall (United Kingdom), Cairo West (Egypt), Incirlik (Turkey) and Andravidn (Greece). During the Southeast Asia conflict, B-52Hs operated out of Andersen (Guam) and U Tapao (Thailand). Bases in Alaska and South Korea may be important for any northeast Asia contingencies. Even when forward bases are secured, denial of overflight privilege by neighboring countries could mitigate some of their benefits.

Operationally, both the reduced numbers of tankers required to support B-52H operations as well as the increased range of bombers can help compensate for lack of forward basing and overflight privilege.

V. Explosive Start Capability

The B-52H and the B-2 are the two SIOP capable bombers in the inventory. The B-52H currently meets fast start requirements for the SIOP mission by using an explosive cartridge to start the engines. These cartridges are part of the logistics set deployed with the B-52H, adding to logistics burden and creating explosive safety issues. The new engines proposed will not have an explosive start capability. Boeing has suggested using an auxiliary power unit to satisfy the fast start requirement.

The APU would provide stand-alone support by eliminating the need for start carts. This also eliminates 8.5 pallets from the mobility footprint, or about one half of one C-17 load. This is not a significant decrease.

If the USAF decides to re-engine the B-52H, the capability for explosive engine starts would be lost. If an operational requirement for self-starting exists, the USAF should conduct a separate evaluation to determine feasibility of installing an internal APU. This task force was of the opinion that an engine self-start capability no longer appeared to be a core need, but clearly the Air Force needs to evaluate such an operational decision.

VI. Environmental Effects of Re-Engining

The task force considered local air quality, global climate change and community noise impacts of re-engining. Environmental performance of new engines is better in some respects, and worse in others.

Local air quality includes both oxides of nitrogen (precursors to smog), and particulate emissions. NOx (nitrogen oxides) will nearly double with the new engines. A conservative estimate shows an increase of about 100 tons/year at base locations. Particulates cause the black smoke visible during B-52H takoffs, and would decrease significantly with re-engining. At most of the base locations for B-52H, this local air quality is not a significant issue. In 1984, the Environmental Protection Agency began regulating aircraft emissions for smoke and fuel venting (unburned hydrocarbons). In 1997, the EPA expanded the rules to include nitrous oxides and carbon monoxide, in accordance with International Civil Aviation Organization (ICAO) standards. The current TF33-103 engine does not comply with current standards, but re-engining will bring the B-52H into compliance.

The other environmental factor the task force examined was the impact on global climate change. There are two ways to consider the effects of re-engining on global climate change. First, is the result from the B-52H aircraft only. Second, is to consider the impact of the reduced need for in-flight refueling and avoided tanker sorties. Considering the B-52H alone, the contribution to global climate change is likely to be worse with re-engining. The radiative forcing factor for all effluents except NOx is 0.060, and the radiative forcing factor for NOx is 0.011. All effluents except NOx will go down by 30%, but cruise NOx will go up by a factor of about two. So the net effect is that the climate impact will be slightly worse even though the fuel burn and consequently, the carbon dioxide emissions, are reduced significantly.[14] While based on radiative forcing the 1,092 gallons per hour of fuel burn do not offset the increased rate of NOx generation, there is considerable uncertainty about the contribution of NOx to global climate change. If considering the secondary effects of avoided tanker sorties, the calculation becomes even more uncertain. First, quantifying the total number of tanker sorties offset by re-engining was indeterminable within the scope of the task force study. Second, each of the tankers (KC-135E, KC-135R and KC-10) has different emissions profiles. For example, if sufficient tanker flying hours are reduced, it could more than offset the higher NOx emissions from the new B-52H engines. Finally, there is the issue of contrails. Contrails are just being studied as significant contributors to global climate change, and are more likely to be formed by re-engined B-52Hs than by the TF33-103 engines. It is not possible to estimate this impact.

Noise is likely to be reduced significantly. At 1000 foot flyover a B757 is about 15 EPNdB quieter than a B-52H. If we add 3dB for the effect of doubling the number of engines, we get a 12EPNdB reduction. This equates to a reduction of more than one-half the annoyance per operation from a community perspective. The current TF33-103 does

[14] Greener by Design, by the Society of British Aerospace Companies, 2001

not meet Stage III noise standards, but after re-engining the B-52H would be in compliance with this international standard.

Considering only the B-52H fleet, and not the reductions associated with reduced tanker use, emissions of carbon dioxide, carbon monoxide and smoke would decrease by 30% or more whereas emissions of oxides of nitrogen are expected to increase by roughly a factor of two. Community noise impacts would be reduced significantly, with about half the annoyance per operation. The task force judges the net effect of these changes to be indeterminable within the scope of this study, but the effect will ultimately depend on the overall impact on tanker flying hours.

VII. Program Options and Risk

VII.a – Program Options

There are three phases to the concept briefed by Boeing:

1) \$3M study to determine cost, benefits and develop an executable program
2) 4-year \$227.7M EMD phase following initial study
3) 6-year production, overlapping EMD by two years.

There are 4 possible financing options

- Conventional DoD Funded Acquisition
- Lease
- Energy Savings Performance Contract (ESPC)
- Hourly Rate

There are 3 engine manufacturers offering 4 feasible engine options:

- Rolls-Royce RB-211
- Pratt & Whitney PW-2040
- GE:
  - CF6-50 (KC-10)
  - CF6-80C2 (VC-25 / C-5M, KC-767)

These combinations lead to 8 feasible financing options, as discussed below. Overlaying 4 possible engine options for each of these, plus the two options of doing nothing (baseline) and modernizing the TF33-103 (current Air Force plan), results in a 34 possible combinations of financing and engine options.

The robust worldwide commercial support base for the proposed engines allows a wide range of support options. These include:

- Air Force Organic
- Air Force on-wing; contractor off-wing
- Full Contract Maintenance

Maintenance options affect program cost, the statutory 50/50 depot maintenance split, depot overhead rates, and possibly raise issues about reliance on contractor maintenance in contingency settings. This also results in a total possible of over 100 different program options involving choices of financing mechanisms, engine choices and maintenance schemes.

Each of the main factors - financing, engines and maintenance - results in a large number of program options and should be addressed in detail by the initial \$3M study.

VII.b – Program Risk

Replacing 8 TF33-103 engines with 4 modern high-bypass COTS engines involves more than just engine replacement. The new engines will be approximately 500

to 600 lbs heavier than the old engines, produce about 9 thousand pounds more thrust per pylon (about 36 thousand pounds total), add about 5,400 lbs to the airframe, and change the moments on the wings. These changes will affect the yaw that would be experienced in the event of an engine failure on takeoff. The solution may require installation of an auto rudder to counteract the differential thrust between wings that would result from engine failure during takeoff, and possibly an auto throttle to sense the engine failure and reduce power on the remaining 3 engines. This and a number of other technical considerations would require modifications to the aircraft such as structural changes to struts, new flight control features and wiring. The extent of the modifications is shown in Figure 12. The task force suggested in the event differential thrust becomes an issue, instituting a standard operational practice of taking off with engine throttles set at the single engine failure power setting would mitigate the problem, as well as save engine life, provide additional power for climb after gear and flap retraction, and make engine failure a non-event.

In its 1996 evaluation of the Boeing proposal, the Air Force Integrated Product Team identified 3 major risk areas; program management, systems engineering, and contracts and cost affordability. The Air Force rated them respectively, low risk, moderate risk and high risk, as shown in Table 6. Factors have changed since the original assessment that would revise some risk judgments, and in others the task force recommends revisiting the conclusions.

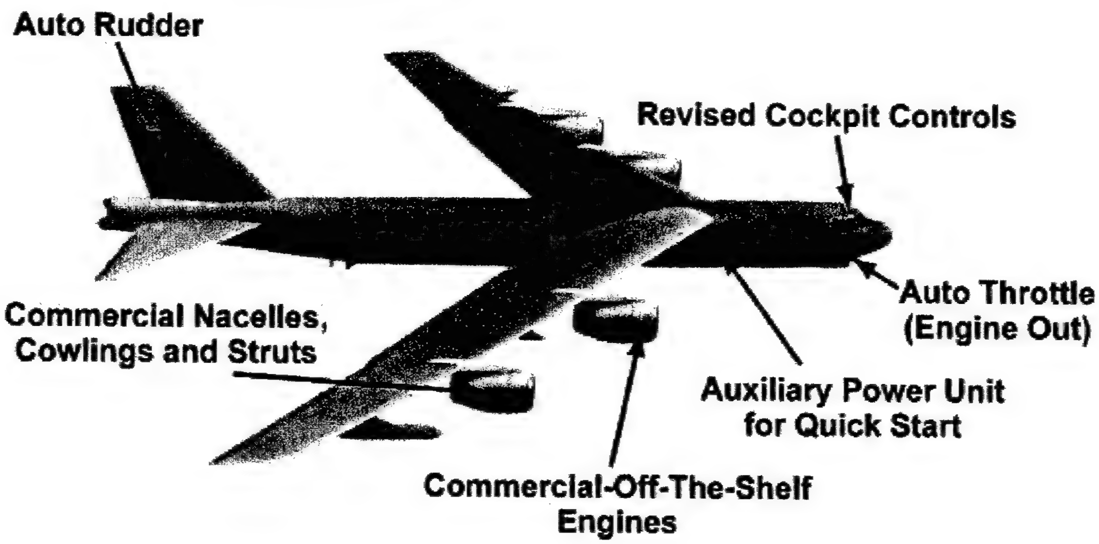


Figure 12: Modifications Required for B-52H Re-engining

The Air Force concluded the systems engineering area represented a moderate risk because:

- The proposed APU is not certified for use during flight
- The proposed APU is not nuclear hardened (not a current requirement)

- The proposed electrically powered hydraulic pumps should be more reliable pump since no alternate source of hydraulic power is available for the systems served. (Note: this is not a change from the current system)
- There is no analysis of high thrust loads on aircraft structure.

The APU is used for SIOP starts, and need not be flight certified and there is no requirement for it to be flight certified. The hydraulic pumps represent no change to the current condition. The SPO conducted a structural analysis of the impact of the new engines, and concluded negligible change in structural life. The task force is of the opinion the overall risk determination of "moderate" is not supportable based on the data available.

The IPT rated contracts and cost/affordability a high risk because of the projected affect on AF TOA, lack of a final force structure decision by the Quadrennial Defense Review, and the difficulty on predicting events 20-30 years in the future upon which the re-engining decision must be made. The task force has identified a strong connection between re-engining and the cost of operating the tanker force. Significant increases in TF33-103 maintenance costs and new innovative financing options combine to offer the Air Force an opportunity to significantly reduce the TOA impact of operating its bomber and tanker fleets. The task force does not consider affordability a high program risk factor.

		RISK	OVERALL AREA RISK
AREA 1	PROGRAM MANAGEMENT		L
	Management	L	
	Configuration Control/Maintenance	M	
	Data	L	
	Logistics	L	
AREA 2	SYSTEMS ENGINEERING		M
	Engines	L	
	Integration	M	
	Test	L	
	Reliability and Maintainability	L	
	Quality	L	
	Safety	L	
	Statement of Work	M	
AREA 3	CONTRACTS AND COSTS/AFFORDABILITY		H
	Contracts	L	
	Cost/Affordability	H	

Table 6: Air Force 1996 Assessment of Program Risk[15]

The Air Force has conducted two separate re-enginings of the KC-135. One for the active force and the other for the Air National Guard. The Air Force considers both programs highly successful in terms of result, cost and schedule. In addition to engines, the program included modifications to landing gear, nacelles, struts and cockpit controls.

The KC-135A's original engines, like those of the B-52H, were also 1950s vintage TF33-103s and didn't meet modern standards for fuel efficiency, pollution or noise levels. By installing new, CFM56 engines, the Air Force enhanced performance and fuel off-load capability dramatically. The modified airplane is designated a KC-135R. Two-re-engined KC-135Rs can do the work of three KC-135As.

This improvement is a result of the KC-135R's lower fuel consumption and increased performance, allowing the tanker to take off with more fuel and carry it farther. Since the airplane can carry more fuel and burn less of it during a mission, it's possible to transfer a much greater amount to receiver aircraft.

The quieter, more fuel-efficient CFM56 engines are manufactured by CFM International, a company jointly owned by SNECMA of France, and General Electric of the U.S. The engine is an advanced modern, high- bypass turbofan; the military designation is F108-CF-100. Related system improvements are incorporated to improve the modified airplane's ability to carry out its mission, while decreasing overall maintenance and operation costs.

Because the KC-135R uses as much as 27 percent less fuel than the KC-135A, the USAF can expect huge fuel savings by re-engining its fleet of KC-135s - about $1.7 billion over 15 years of operation, or about three to four percent of the USAF's annual fuel use.

Re-engining with the CFM56 engines also significantly reduces noise, and allows the KC-135R to meet Federal Air Regulation standards. Areas surrounding airports exposed to decibel noise levels is reduced from over 240 square miles to about three square miles. This results in a reduction in the noise impacted area of more than 98 percent. In addition, smoke and other emission pollutants are reduced dramatically.

Boeing has delivered approximately 400 re-engined KC-135Rs and is under contract for about 432 re-engine kits. Each kit includes struts, nacelles, 12.2 miles of wiring, and other system modification components. The Air Force is purchasing engines directly from CFM International.

Boeing has also completed previous programs to re-engine KC-135As in the Air Force Reserve and Air National Guard -- a total of 161 airplanes. In that program, which began in 1981, KC-135As were modified with refurbished JT3D engines taken from

[15] Reproduced from Air Force Re-Engining IPT, Final Report "Analyis of the Boeing Unsolicited Proposal to Re-Engine the B-52H", 1996

used, commercial 707 airliners. After modification, the airplanes are designated KC-135Es. This upgrade, like the KC-135R program, boosts performance while decreasing noise and smoke pollution levels. The modified KC-135E provides 30 percent more powerful engines with a noise reduction of 85 percent.

The task force concludes that a B-52H re-engining program represents low risk in the areas of program management, systems engineering, and affordability based on a re-assessment of the factors considered in the 1996 IPT evaluation.

VIII. Recapitalization Costs and Innovative Financing

Options	Study	EMD	Production	Feasible
1	DoD Fund	DoD Fund	DoD Fund	Yes
2	DoD Fund	DoD Fund	Lease	Yes
3	DoD Fund	DoD Fund	ESPC	Yes
4	DoD Fund	DoD Fund	Hourly Rate	Yes
5	DoD Fund	Lease	DoD Fund	Yes[16]
6	DoD Fund	Lease	Lease	Yes
6	DoD Fund	Lease	ESPC	Yes
6	DoD Fund	Lease	Hourly Rate	Yes
7	DoD Fund	ESPC	DoD Fund	Yes[11]
8	DoD Fund	ESPC	Lease	Yes
8	DoD Fund	ESPC	ESPC	Yes
	DoD Fund	ESPC	Hourly Rate	No
	DoD Fund	Hourly Rate	DoD Fund	No
	DoD Fund	Hourly Rate	Lease	No
	DoD Fund	Hourly Rate	ESPC	No
	DoD Fund	Hourly Rate	Hourly Rate	No

Table 7: Financing Options

The total program cost will depend more on the financing option chosen than on the choice of new commercial engine, with two exceptions. Modernizing the existing TF33-103 would result in a cheaper first cost, regardless of financing options chosen. Refurbishing some newer GE engines currently owned by the Air Force could also give a cheaper first cost, but would be closer in cost to new engines than to TF33-103 modernization, as will be discussed later. The financing options are shown in Table 7.

With the exception of an outright buy, each option includes various forms of interest, representing the cost of money. It is also possible to finance the EMD and procurement phases differently. The choices affect program cost and shift program risk. The only option available for completing the study phase is DoD funding. EMD and production can be financed in any of 4 possible ways; conventional DoD acquisition funding, lease, Energy Service Performance Contract, or payments based on hourly use rates.

[16] Options 5 and 7 represent a strategy in which the DoD would agree to either lease or ESPC terms for both the EMD and production phases, with an option to buy out the production phase. Performance and maintenance guarantees with lease and ESPC provides the contractor an incentive to complete the EMD effectively and efficiently and minimize any potential for unexpected modifications during production.

VIII.a – Purchase as a Major Modification Using Procurement (3010) Appropriations

The least cost option for the procurement phase is to buy the program outright by programming a major modification using appropriated funds. This avoids any interest or risk payments to financing institutions, venture capitalists or brokers. Proper incentive structures manage the continuum between cost and risk, minimizing the potential for unexpected costs and slippage to the government and providing an appropriate return to the contractor. All other options involve payments to private entities for the use of money, as in a mortgage (ESPC as explained below), or a lease.

VIII.b – Capital Lease Through OEM Using O&M Appropriations

While leasing is a useful tool for commercial entities, many of the factors that make leasing attractive do not apply to the federal government. Perhaps as instructive are the few instances where leasing would be advantageous to the government.

Leasing is a profit-generating venture by the business granting the lease (i.e, the lessor). This suggests that, in general, owning is preferable to leasing. Commercial entities, however, do find leasing attractive under several circumstances:

- Tax advantages: Lease payments can be counted as immediate expenses against current revenue while capital purchases are usually depreciated over the life of the asset.

- Capital constraints: Commercial entities may not be able to borrow funds for both core and non-core capital investments. Given this constraint, it is logical to invest in expanding the core business while leasing non-core assets on a year-to-year basis.

Neither of these conditions generally applies to the federal government or to DoD. DoD does not pay taxes and is not theoretically capital constrained (or at least can borrow on more advantageous terms than a private company can). There are, however, a few cases where the government's (as well as private firm's) best alternative is to lease:

- Short-term use: Suppose the time that the government needs the asset is much less than it's useful life, and a private market exists for the good. In this instance, if the purchase and sale of the asset are sufficiently costly, efficiency gains may exist by leasing from a private provider.

- Risk transfer: Leasing can transfer risk to the lessor if the responsibility for breakdown and maintenance lies with the lessee rather than the lessee. The government is better able to accept risk than most private entities, but may desire to transfer risk to provide the leasing manufacturer incentives to produce a more reliable product.

Lessor cost advantage - The lessor may be able to own a capital good at a lower cost than the lessee may. Examples occur when:

- the lessor's cost of capital is lower than the lessee's cost of capital (applicable to private entities, not the federal government)
- there are economies of scale to owning a larger fleet than the lessee needs
- the lessor has access to markets that generate higher salvage value than the lessee has access to; and
- corporate accounting procedures make leasing improve the corporate balance sheet.

These examples provide broad guidelines for analyzing proposed leases. Except in a few instances, it is not in the federal government's interest to lease. For those exceptions, agencies must make a clear case as to what makes leasing more economically efficient and how the government will share in the benefits of those efficiencies. It was unclear that any conditions exist in the case of re-engining that make leasing the most attractive alternative.

VIII.c – The Energy Savings Performance Contracts (ESPC) Program

In its evaluation of Boeing's 1996 proposal, the Air Force cited affordability as a significant issue. To address this, Boeing has recently proposed using Energy Savings Performance Contracts (ESPC) as a way to avoid TOA impact.

Congress authorized ESPC in the National Energy Conservation Act, and amended under the National Energy Policy Act of 1992. Its purpose was to enable private funding to be used to upgrade federal facilities to make them more energy efficient, and to repay that investment from the savings stream produced through reduced utility bills. Figure 13 shows how savings are used to repay the private financing. ESPC was authorized because federal facilities required significant upgrades, it was not possible to provide adequate appropriated funds to accomplish the work in a reasonable time, and there was an increasing recognition that improving the energy efficiency of federal facilities would reduce facility operating costs.

The legislation allows multi-year contracting authority for periods not to exceed 25 years. During the period of the contract, most, and sometimes all, of the O&M savings stream is paid to the contractor until the contract is satisfied. After the contract is paid off, the government is able to keep all the savings.

Initially authorized as a 5-year pilot program, ESPC was subsequently made permanent, and the executive branch was directed to establish procedures and implement the program. A series of executive orders have continued to mandate reductions in energy consumption at federal facilities, and ESPC is a widely used means for obtaining adequate investment to achieve the goals.

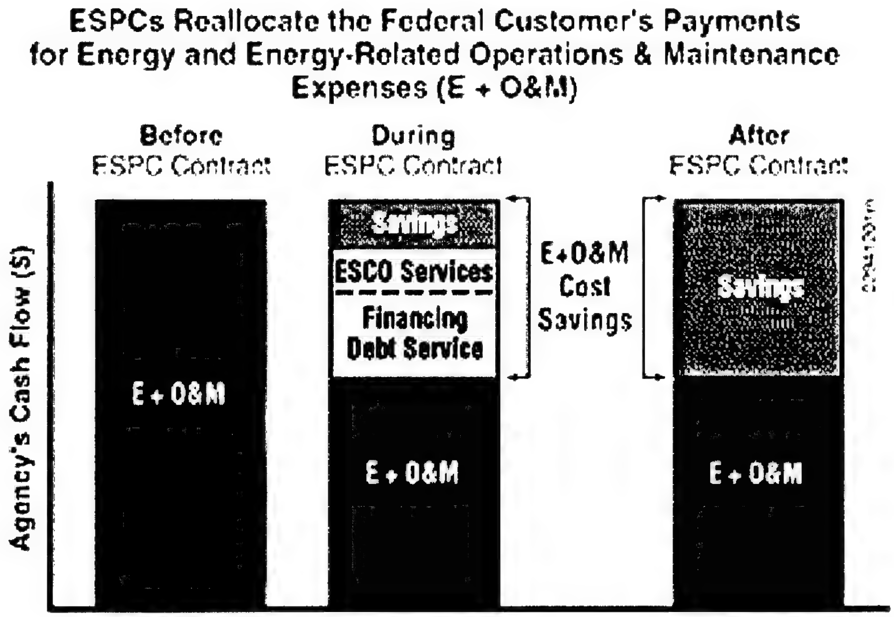


Figure 13: How ESPC's Work

The Department of Energy published the final rule on Energy Savings Performance Contracts on April 10, 1995. Federal Acquisition Rules:

- Permit multi-year contracts without scoring current year's appropriations for capital costs
- Permit termination liability schedule Government would pay in event of a Termination
- Require Monitoring and Verification (M&V) plan to measure program savings, from which payments are made
- Require Congressional notification for large projects (such as B-52H re-engining)

All ESPCs must have contractor guaranteed savings, which are tested and ensured through a measurement and verification (M&V) Plan. M&V can occur only once, at Government acceptance; or annually throughout the contract period. During the proposal phase, the contractor and Government agree on an acceptable M&V Plan. Costs of M&V are included in the contract and paid to the contractor along with debt and service payments.

ESPCs provide capital improvement to the Government at no up-front cost. Payments to the contractor are made from reductions in O&M bills created by increased energy efficiency. The contractor guarantees the savings, and the Government pays out of actual savings only. Statute requires then year dollars be used for the analysis.

DoD installations have used ESPC successfully since 1988 to provide $800Million to improve the efficiency of energy consuming systems, reduce utility bills

and achieve the efficiency mandates imposed by legislation and executive orders. While ESPC is recognized as the high-cost solution to financing capital projects, it does reduce the total expenditure by the government over the economic life of the upgraded system, but not nearly as much as would have been saved had the investments been made from appropriated funds.

However, there are two issues relevant to the use of ESPCs in this case. First, ESPC has never been used for mobility systems. It has only been used for fixed facilities. This is because the statute authorizing the program does not explicitly include its use for mobile systems. Boeing has proposed interpreting Executive Order 13123 as authorizing the use of ESPC for mobile systems (Appendix C). Specifically, Boeing cites sections 405 and 709, which address efficiency in mobile equipment. It is not clear to the task force that the executive order explicitly provides the necessary authorization to use ESPC for mobile equipment, however interpretation by General Counsel will be necessary to make such a determination. The second factor to consider is that the some of the savings that would be used to repay the contract is currently being spent operating the Air Force tanker fleet. Releasing those funds as savings would require retiring tanker aircraft. In the event tankers are in shortage and re-engining will be used as a means to purchase additional tanker capacity, then using ESPC to re-engine would be a defacto decision by the Air Force to dedicate a greater amount of TOA to tanker operations, and to divert additional TOA to repay the ESPC contract.

The task force recommends DoD investigate ESPC as a possible mechanism for re-enging mindful of the following findings:

- Commercial history of modern high bypass fan engines provides a sound basis for calculating fuel and maintenance costs and for devising a M&V plan
- While used only for facility investments to date, Executive Order 13123 dated June 3, 1999 specifically addresses efficiency in "Mobile Equipment", and may provide a basis for making a legal determination that ESPCs can be applied to B-52H re-engining.[17]
- B-52H re-engining appears to be consistent with the intent of the ESPC Program in that it improves the efficiency of government equipment.
- Use of ESPC will increase the program cost and decrease the economic benefit of re-engining.
- In the event O&M savings from reduced fuel purchase and maintenance costs are inadequate to finance the ESPC contract, some funding from reduced tanker fleet operations may also be needed.

It appears possible that the O&M outlays described in Section II.3 "Economic Summary" above could provide a sufficient funding stream to finance re-engining using ESPC and produce a net positive impact on Air Force TOA. However, definitive figures for costs and savings can only be developed through negotiations with Boeing and a more detailed analysis of future savings streams.

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[17] Sections 405 and 709

The task force concludes B-52H re-engining would serve as a good pilot program for expanding the ESPC Program in practice beyond facilities, and into mobility systems.

VIII.d – Rent Use on an Hourly Basis

This approach is being tested by the Navy for in-flight refueling services, known as the Omega contract. The Navy has investigated "power-by-the-hour" for the V-22 aircraft, but has not implemented it yet.[18] Commercial airline executives cautioned the task force that negotiating hourly rate requires a very sophisticated management team. The contracts typically provide for cost only, and do not address reliability. Furthermore, unlike long-term leases, the contracts must be renewed periodically. Negotiating clauses for the reliability side of the equation can be tricky.

[18] "Power-by-the-Hour" is a trademarked name by Rolls-Royce, and is not the generic term for renting aircraft power on an hourly basis.

IX. Conclusions and Recommendations

IX.a – Conclusions

The task force made the following seven conclusions:

1. The B-52H is the most versatile and cost effective bomber in the inventory and re-engining makes it even more so.

2. The B-52H has the highest mission capable rate of any of the 3 bombers, and is the only Conventional Air Launched Cruise Missile (CALCM) capable platform in the inventory.

3. That further significant reductions in the B-52H fleet are unlikely for the foreseeable future because:
   - The total assigned inventory (TAI) bomber fleet being reduced from 130 to 96, a deminimis number
   - There is no bomber aircraft currently in development
   - The B-52H is highly capability of accomplishing its assigned missions
   - The B-52H is flexible and able to adapt to future missions
   - The USAF chose to retire more than twice as many B-1 airframes as B-52H airframes
   - USAF has stated its intention to retain the B-52H through 2037

4. B-52H re-engining program represents low risk in the areas of program management, systems engineering, and affordability based on a re-assessment of the factors considered in the 1996 IPT evaluation.

5. B-52H re-engining is an attractive opportunity for the following financial and operational reasons:
   - Greater operational flexibility
   - Greater range
   - Reduced fuel burn
   - Reduced tanker demand
   - Depot savings through elimination of off-airframe engine maintenance
   - Field maintenance manpower savings

6. B-52H re-engining would serve as a good pilot program for expanding the ESPC Program in practice beyond facilities, and into mobility systems.

7. The task force concludes the economic and operational benefits far outweigh the program cost.

The task force offers the following six recommendations:

1. The Air Force proceed with B-52H re-engining without delay and place the program on a fast acquisition track in order to maximize the benefits and take advantage of the current business climate.

2. The Air Force proceed with a dedicated study to determine the optimum program, considering all the possible engines, service arrangements and financing options.

3. OSD commission a new independent long-term tanker requirements study that extends beyond FY05, based on new planning guidance, which includes the ability to conduct sensitivity analyses of B-52H re-engining as well as other planned and potential new receiver aircraft that will be in service over the expected lifetime of the tanker force, such as JSF.

4. The SPO and Boeing investigate the impact of eliminating low-level missions on projections of future airframe economic lifetime.

5. OSD and the Air Force investigate whether authority exists to use an Energy Savings Performance Contract or if legislative clarification is needed; and confirm the economic viability of Energy Savings Performance Contracting as a financing mechanism for B-52H re-engining.

6. OSD investigate the use of more robust analytical tools that allow the value of improved operational capabilities to be included in cost-benefit analyses used to support programmatic decision-making.

Appendix A: Terms of Reference

THE UNDER SECRETARY OF DEFENSE

3010 DEFENSE PENTAGON
WASHINGTON, DC 20301-3010

ACQUISITION,
TECHNOLOGY
AND LOGISTICS

26 JUN 2002

MEMORANDUM FOR CHAIRMAN, DEFENSE SCIENCE BOARD

SUBJECT: Terms of Reference -- Defense Science Board Task Force on B-52 Re-Engining

You are requested to form a Defense Science Board (DSB) Task Force to review and advise on key aspects of the policy and technology issues associated with re-engining the USAF B-52 fleet.

This weapons system, first placed into service in the late 1950s and last manufactured in 1962, will likely remain in remain in inventory as late as 2040. Given its projected use in a variety of scenarios and situations, it is prudent to consider steps to ensure its continued viability.

The Air Force has recently modernized the KC-135 tanker an RC-135 fleets with new engines. Given the projected retention of the B-52 for several decades into the future, it is prudent to examine and assess B-52 re-engining from the perspectives of:

- effective operational weapons system employment, to include tanker demands;
- efficient ground and flight operations, to include fuel consumption factors;
- engine reliability and systems performance;
- technical and supportability risks of remaining with the TF-33 engine;
- streamlined support concepts from a best value viewpoint, to include total contractor support;
- implementation issues, to include conventional as well as innovative acquisition and financing;
- contracting and legal considerations- -to include termination issues; and
- affordability of re-engining as compared to life extension concepts

This study should take no more than 90 days. Completed work should be submitted to the office of the Defense Science Board Secretariat not later than September 30, 2002.

The Task Force will be sponsored by me as the USD (AT&L). The Director, Strategic and tactical Systems (S&TS) will support the task force. General Michael P. C. Carns, USAF (Ret.) will serve as the Task Force Chairman. Col Jon Link, (S&TS-AW), will serve as the Executive Secretary. LtCol Roger W. Basl will serve as the Defense Science Board Secretariat representative.

The Task Force will operate in accordance with the provisions of P.L. 92-463, the "Federal Advisory Committee Act" and DoD Directive 5105.4, the "DoD Federal Advisory Committee Management Program." It is not anticipated that this Task Force will need to go into any "particular matters" within the meaning of section 208 of Title 18, U.S. Code, nor will it cause any member to be placed in the position of acting as a procurement official.

E. C. Aldridge, Jr.

Appendix B: Task Force Membership

Chairman	
Gen Mike Carns (USAF, Ret)	Vice Chairman, PrivaSource, Inc.
Members	
Mr. Samuel Adcock	EADS, Inc
Gen George Babbitt, (USAF, Ret)	Consultant
Mr. Michael Bayer	Consultant
Mr. John Douglass	Aerospace Industries Association
Dr. Jacques Gansler	University of Maryland
Dr. Ian A. Waitz	Massachusetts Institute of Technology
Mr. Sandy Webb	Environmental Consulting Group, LLC
Mr. Robert Yountz	Pratt & Whitney
Government Advisors	
Col. Louise Eckhardt	AF/ILMY
Mr. John Hutto	AF/XORC
Maj. Joseph P. McDonnell	AF/XORC
Dr. Jerry Pannullo	OSD (Program Analysis and Evaluation)
Mr. Stephen Seidel	Environmental Protection Agency
Ms. Cindy Newberg (Alternate)	Environmental Protection Agency
Executive Secretary	
Col. Jon Link	OSD (AT&L) / S&TS
DSB Secretariat	
LtCol Roger W. Basl	OSD/AT&L/Defense Science Board
Task Force Support	
Mr. E. Thomas Morehouse, Jr.	Institute for Defense Analyses
Task Force Sponsor	
Mr. E.C. Aldridge, Jr.	Under Secretary of Defense (Acquisition, Technology and Logistics)

Appendix C: Presentations to the Task Force

June 25, 2002

Mr Tom Morehouse	Findings of DSB Task Force on Fuel Efficiency, Previous AF Study on Re-Engining B-52H and 707 VariantsIDA
Joshua Schwartz, Wayne Devers	IDA Studies on B-52H Re-Engining and Tanker RequirementsIDA

July 15, 2002

Col O'Donnell	AF Vision Brief, AF/XPX
Col Jim McGinley	B-52H Lifetime Projection Analysis and Impact of Re-Engining, OC-ALC
Maj Joe McDonnell	Long Range Time Phase Bomber Plan, B-52H Utilization in Serbia and Afghanistan and Airbridge Statistics AF/XORC
Mr Dave Merrill, Maj Dave Ryer	AMC Tanker Study TRS-05 and AOA Plans, AMC/XPY

August 27-28, 2002

Mr Ray Valeika	A Commercial Case for Investing in Improved Aircraft Efficiency, VP Technical Operations, Delta Airlines
Joshua Schwartz	B-52H Re-Engining Impact on Tanker Requirements for Current SIOP, IDA
Al Wang	PW-2040 Engine – Longevity and Supportablity, Pratt & Whitney
Lee Wilkerson	CF-6 Engine – Longevity and Supportability, General Electric
Ken Roberts, Ron Riffel, Bill McGuth, Ken Perich	RB-211 – Longevity and Supportability, Rolls Royce
John Kegley	Boeing's B-52H Engine Modernization Concept

September 23, 2002

No Presentations – Report Writing and Editing Session

Appendix D: Executive Order 13123 - Greening the Government Through Efficient Energy Management

By the authority vested in me as President by the Constitution and the laws of the United States of America, including the National Energy Conservation Policy Act (Public Law 95-619, 92 Stat. 3206, 42 U.S.C. 8252 et seq.), as amended by the Energy Policy Act of 1992 (EPACT) (Public Law 102-486, 106 Stat. 2776), and section 301 of title 3, United States Code, it is hereby ordered as follows:

Part 1 - Preamble

Section 101. Federal Leadership. The Federal Government, as the Nation's largest energy consumer, shall significantly improve its energy management in order to save taxpayer dollars and reduce emissions that contribute to air pollution and global climate change. With more than 500,000 buildings, the Federal Government can lead the Nation in energy efficient building design, construction, and operation. As a major consumer that spends $200 billion annually on products and services, the Federal Government can promote energy efficiency, water conservation, and the use of renewable energy products, and help foster markets for emerging technologies. In encouraging effective energy management in the Federal Government, this order builds on work begun under EPACT and previous Executive orders.

Part 2 - Goals

Sec. 201. Greenhouse Gases Reduction Goal. Through life-cycle cost-effective energy measures, each agency shall reduce its greenhouse gas emissions attributed to facility energy use by 30 percent by 2010 compared to such emissions levels in 1990. In order to encourage optimal investment in energy improvements, agencies can count greenhouse gas reductions from improvements in nonfacility energy use toward this goal to the extent that these reductions are approved by the Office of Management and Budget (OMB).

Sec. 202. Energy Efficiency Improvement Goals. Through life-cycle cost-effective measures, each agency shall reduce energy consumption per gross square foot of its facilities, excluding facilities covered in section 203 of this order, by 30 percent by 2005 and 35 percent by 2010 relative to 1985. No facilities will be exempt from these goals unless they meet new criteria for exemptions, to be issued by the Department of Energy (DOE).

Sec. 203. Industrial and Laboratory Facilities. Through life-cycle cost-effective measures, each agency shall reduce energy consumption per square foot, per unit of production, or per other unit as applicable by 20 percent by 2005 and 25 percent by 2010 relative to 1990. No facilities will be exempt from these goals unless they meet new criteria for exemptions, as issued by DOE.

Sec. 204. Renewable Energy. Each agency shall strive to expand the use of renewable energy within its facilities and in its activities by implementing renewable energy projects and by purchasing electricity from renewable energy sources. In support of the Million Solar Roofs initiative, the Federal Government shall strive to install 2,000 solar energy systems at Federal facilities by the end of 2000, and 20,000 solar energy systems at Federal facilities by 2010.

Sec. 205. Petroleum. Through life-cycle cost-effective measures, each agency shall reduce the use of petroleum within its facilities. Agencies may accomplish this reduction by switching to a less greenhouse gas-intensive, nonpetroleum energy source, such as natural gas or renewable energy sources; by eliminating unnecessary fuel use; or by other appropriate methods. Where alternative fuels are not practical or life-cycle cost-effective, agencies shall strive to improve the efficiency of their facilities.

Sec. 206. Source Energy. The Federal Government shall strive to reduce total energy use and associated greenhouse gas and other air emissions, as measured at the source. To that end, agencies shall undertake life-cycle cost-effective projects in which source energy decreases, even if site energy use increases. In such cases, agencies will receive credit toward energy reduction goals through guidelines developed by DOE.

Sec. 207. Water Conservation. Through life-cycle cost-effective measures, agencies shall reduce water consumption and associated energy use in their facilities to reach the goals set under section 503(f) of this order. Where possible, water cost savings and associated energy cost savings shall be included in Energy Savings Performance Contracts and other financing mechanisms.

Part 3 - Organization And Accountability

Sec. 301. Annual Budget Submission. Each agency's budget submission to OMB shall specifically request funding necessary to achieve the goals of this order. Budget submissions shall include the costs associated with encouraging the use of, administering, and fulfilling agency responsibilities under Energy Savings Performance Contracts, utility energy-efficiency service contracts, and other contractual platforms for achieving conservation goals; implementing life-cycle cost-effective measures; procuring life-cycle cost-effective products; and constructing sustainably designed new buildings, among other energy costs. OMB shall issue guidelines to assist agencies in developing appropriate requests that support sound investments in energy improvements and energy-using products. OMB shall explore the feasibility of establishing a fund that agencies could draw on to finance exemplary energy management activities and investments with higher initial costs but lower life-cycle costs. Budget requests to OMB in support of this order must be within each agency's planning guidance level.

Sec. 302. Annual Implementation Plan. Each agency shall develop an annual implementation plan for fulfilling the requirements of this order. Such plans shall be included in the annual reports to the President under section 303 of this order.

Sec. 303. Annual Reports to the President. (a) Each agency shall measure and report its progress in meeting the goals and requirements of this order on an annual basis. Agencies shall follow reporting guidelines as developed under section 306(b) of this order. In order to minimize additional reporting requirements, the guidelines will clarify how the annual report to the President should build on each agency's annual Federal energy reports submitted to DOE and the Congress. Annual reports to the President are due on January 1 of each year beginning in the year 2000.

(b) Each agency's annual report to the President shall describe how the agency is using each of the strategies described in Part 4 of this order to help meet energy and greenhouse gas reduction goals. The annual report to the President shall explain why certain strategies, if any, have not been used. It shall also include a listing and explanation of exempt facilities.

Sec. 304. Designation of Senior Agency Official. Each agency shall designate a senior official, at the Assistant Secretary level or above, to be responsible for meeting the goals and requirements of this order, including preparing the annual report to the President. Such designation shall be reported by each Cabinet Secretary or agency head to the Deputy Director for Management of OMB within 30 days of the date of this order. Designated officials shall participate in the Interagency Energy Policy Committee, described in section 306(d) of this order. The Committee shall communicate its activities to all designated officials to assure proper coordination and achievement of the goals and requirements of this order.

Sec. 305. Designation of Agency Energy Teams. Within 90 days of the date of this order, each agency shall form a technical support team consisting of appropriate procurement, legal, budget, management, and technical representatives to expedite and encourage the agency's use of appropriations, Energy Savings Performance Contracts, and other alternative financing mechanisms necessary to meet the goals and requirements of this order. Agency energy team activities shall be undertaken in collaboration with each agency's representative to the Interagency Energy Management Task Force, as described in section 306(e) of this order.

Sec. 306. Interagency Coordination. (a) Office of Management and Budget. The Deputy Director for Management of OMB, in consultation with DOE, shall be responsible for evaluating each agency's progress in improving energy management and for submitting agency energy scorecards to the President to report progress.

(1) OMB, in consultation with DOE and other agencies, shall develop the agency energy scorecards and scoring system to evaluate each agency's progress in meeting the goals of this order. The scoring criteria shall include the extent to which agencies are taking advantage of key tools to save energy and reduce greenhouse gas emissions, such as Energy Savings Performance Contracts, utility energy-efficiency service contracts, ENERGY STAR® and other energy efficient products, renewable energy technologies, electricity from renewable energy sources, and other strategies and requirements listed in Part 4 of this order, as well as overall efficiency and greenhouse gas metrics and use of other innovative energy efficiency practices. The scorecards shall be based on the annual energy reports submitted to the President under section 303 of this order.

(2) The Deputy Director for Management of OMB shall also select outstanding agency energy management team(s), from among candidates nominated by DOE, for a new annual Presidential award for energy efficiency.

(b) Federal Energy Management Program. The DOE's Federal Energy Management Program (FEMP) shall be responsible for working with the agencies to ensure that they meet the goals of this order and report their progress. FEMP, in consultation with OMB, shall develop and issue guidelines for agencies' preparation of their annual reports to the President on energy management, as required in section 303 of this order. FEMP shall also have primary responsibility for collecting and analyzing the data, and shall assist OMB in ensuring that agency reports are received in a timely manner.

(c) President's Management Council. The President's Management Council (PMC), chaired by the Deputy Director for Management of OMB and consisting of the Chief Operating Officers (usually the Deputy Secretary) of the largest Federal departments and agencies, will periodically discuss agencies' progress in improving Federal energy management.

(d) Interagency Energy Policy Committee. This Committee was established by the Department of Energy Organization Act. It consists of senior agency officials designated in accordance with section 304 of this order. The Committee is responsible for encouraging implementation of energy efficiency policies and practices. The major energy-consuming agencies designated by DOE are required to participate in the Committee. The Committee shall communicate its activities to all designated senior agency officials to promote coordination and achievement of the goals of this order.

(e) Interagency Energy Management Task Force. The Task Force was established by the National Energy Conservation Policy Act. It consists of each agency's chief energy manager. The Committee shall continue to work toward improving agencies' use of energy management tools and sharing information on Federal energy management across agencies.

Sec. 307. Public/Private Advisory Committee. The Secretary of Energy will appoint an advisory committee consisting of representatives from Federal agencies, State governments, energy service companies, utility companies, equipment manufacturers, construction and architectural companies, environmental, energy and consumer groups, and other energy-related organizations. The committee will provide input on Federal energy management, including how to improve use of Energy Savings Performance Contracts and utility energy-efficiency service contracts, improve procurement of ENERGY STAR® and other energy efficient products, improve building design, reduce process energy use, and enhance applications of efficient and renewable energy technologies at Federal facilities.

Sec. 308. Applicability. This order applies to all Federal departments and agencies. General Services Administration (GSA) is responsible for working with agencies to meet the requirements of this order for those facilities for which GSA has delegated operations and maintenance authority. The Department of Defense (DOD) is subject to this order to the extent that it does not impair or adversely affect military operations and training (including tactical aircraft, ships, weapons systems, combat training, and border security).

Part 4 - Promoting Federal Leadership in Energy Management

Sec. 401. Life-Cycle Cost Analysis. Agencies shall use life-cycle cost analysis in making decisions about their investments in products, services, construction, and other projects to lower the Federal Government's costs and to reduce energy and water consumption. Where appropriate, agencies shall consider the life-cycle costs of combinations of projects, particularly to encourage bundling of energy efficiency projects with renewable energy projects. Agencies shall also retire inefficient equipment on an accelerated basis where replacement results in lower life-cycle costs. Agencies that minimize life-cycle costs with efficiency measures will be recognized in their scorecard evaluations.

Sec. 402. Facility Energy Audits. Agencies shall continue to conduct energy and water audits for approximately 10 percent of their facilities each year, either independently or through Energy Savings Performance Contracts or utility energy-efficiency service contracts.

Sec. 403. Energy Management Strategies and Tools. Agencies shall use a variety of energy management strategies and tools, where life-cycle cost-effective, to meet the goals of this order. An agency's use of these strategies and tools shall be taken into account in assessing the agency's progress and formulating its score card.

(a) Financing Mechanisms. Agencies shall maximize their use of available alternative financing contracting mechanisms, including Energy Savings Performance Contracts and utility energy-efficiency service contracts, when life-cycle cost-effective, to reduce energy use and cost in their facilities and operations. Energy Savings Performance Contracts, which are authorized under the National Energy Conservation Policy Act, as

modified by the Energy Policy Act of 1992, and utility energy-efficiency service contracts provide significant opportunities for making Federal facilities more energy efficient at no net cost to taxpayers.

(b) ENERGY STAR® and Other Energy-Efficient Products.

(1) Agencies shall select, where life-cycle cost-effective, ENERGY STAR® and other energy-efficient products when acquiring energy-using products. For product groups where ENERGY STAR® labels are not yet available, agencies shall select products that are in the upper 25 percent of energy efficiency as designated by FEMP. The Environmental Protection Agency (EPA) and DOE shall expedite the process of designating products as ENERGY STAR® and will merge their current efficiency rating procedures.

(2) GSA and the Defense Logistics Agency (DLA), with assistance from EPA and DOE, shall create clear catalogue listings that designate these products in both print and electronic formats. In addition, GSA and DLA shall undertake pilot projects from selected energy-using products to show a "second price tag," which means an accounting of the operating and purchase costs of the item, in both printed and electronic catalogues and assess the impact of providing this information on Federal purchasing decisions.

(3) Agencies shall incorporate energy-efficient criteria consistent with ENERGY STAR® and other FEMP- designated energy efficiency levels into all guide specifications and project specifications developed for new construction and renovation, as well as into product specification language developed for Basic Ordering Agreements, Blanket Purchasing Agreements, Government Wide Acquisition Contracts, and all other purchasing procedures.

(4) DOE and OMB shall also explore the creation of financing agreements with private sector suppliers to provide private funding to offset higher up-front costs of efficient products. Within 9 months of the date of this order, DOE shall report back to the President's Management Council on the viability of such alternative financing options.

(c) ENERGY STAR® Buildings. Agencies shall strive to meet the ENERGY STAR® building criteria for energy performance and indoor environmental quality in their eligible facilities to the maximum extent practicable by the end of 2002. Agencies may use Energy Savings Performance Contracts, utility energy-efficiency service contracts, or other means to conduct evaluations and make improvements to buildings in order to meet the criteria. Buildings that rank in the top 25 percent in energy efficiency relative to comparable commercial and Federal buildings will receive the ENERGY STAR® building label. Agencies shall integrate this building rating tool into their general facility audits.

(d) Sustainable Building Design. DOD and GSA, in consultation with DOE and EPA, shall develop sustainable design principles. Agencies shall apply such principles to the siting, design, and construction of new facilities. Agencies shall optimize life-cycle costs, pollution, and other environmental and energy costs associated with the construction, life-cycle operation, and decommissioning of the facility. Agencies shall consider using Energy Savings Performance Contracts or utility energy-efficiency service contracts to aid them in constructing sustainably designed buildings.

(e) Model Lease Provisions. Agencies entering into leases, including the renegotiation or extension of existing leases, shall incorporate lease provisions that encourage energy and water efficiency wherever life-cycle cost-effective. Build-to-suit lease solicitations shall contain criteria encouraging sustainable design and development, energy efficiency, and verification of building performance. Agencies shall include a preference for buildings having the ENERGY STAR® building label in their selection criteria for acquiring leased buildings. In addition, all agencies shall encourage lessors to apply for the ENERGY STAR® building label and to explore and implement projects that would reduce costs to the Federal Government, including projects carried out through the lessors' Energy Savings Performance Contracts or utility energy-efficiency service contracts.

(f) Industrial Facility Efficiency Improvements. Agencies shall explore efficiency opportunities in industrial facilities for steam systems, boiler operation, air compressor systems, industrial processes, and fuel switching, including cogeneration and other efficiency and renewable energy technologies.

(g) Highly Efficient Systems. Agencies shall implement district energy systems, and other highly efficient systems, in new construction or retrofit projects when life-cycle cost-effective. Agencies shall consider combined cooling, heat, and power when upgrading and assessing facility power needs and shall use combined cooling, heat, and power systems when life-cycle cost-effective. Agencies shall survey local natural resources to optimize use of available biomass, bioenergy, geothermal, or other naturally occurring energy sources.

(h) Off-Grid Generation. Agencies shall use off-grid generation systems, including solar hot water, solar electric, solar outdoor lighting, small wind turbines, fuel cells, and other off-grid alternatives, where such systems are life-cycle cost-effective and offer benefits including energy efficiency, pollution prevention, source energy reductions, avoided infrastructure costs, or expedited service.

Sec. 404. Electricity Use. To advance the greenhouse gas and renewable energy goals of this order, and reduce source energy use, each agency shall strive to use electricity from clean, efficient, and renewable energy sources. An agency's efforts in purchasing electricity from efficient and renewable energy sources shall be taken into account in assessing the agency's progress and formulating its scorecard.

(a) Competitive Power. Agencies shall take advantage of competitive opportunities in the electricity and natural gas markets to reduce costs and enhance services. Agencies are encouraged to aggregate demand across facilities or agencies to maximize their economic advantage.

(b) Reduced Greenhouse Gas Intensity of Electric Power. When selecting electricity providers, agencies shall purchase electricity from sources that use high efficiency electric generating technologies when life-cycle cost-effective. Agencies shall consider the greenhouse gas intensity of the source of the electricity and strive to minimize the greenhouse gas intensity of purchased electricity.

(c) Purchasing Electricity from Renewable Energy Sources.

(1) Each agency shall evaluate its current use of electricity from renewable energy sources and report this level in its annual report to the President. Based on this review, each agency should adopt policies and pursue projects that increase the use of such electricity. Agencies should include provisions for the purchase of electricity from renewable energy sources as a component of their requests for bids whenever procuring electricity. Agencies may use savings from energy efficiency projects to pay additional incremental costs of electricity from renewable energy sources.

(2) In evaluating opportunities to comply with this section, agencies should consider my Administration's goal of tripling nonhydroelectric renewable energy capacity in the United States by 2010, the renewable portfolio standard specified in the restructuring guidelines for the State in which the facility is located, GSA's efforts to make electricity from renewable energy sources available to Federal electricity purchasers, and EPA's guidelines on crediting renewable energy power in implementation of Clean Air Act standards.

Sec. 405. Mobile Equipment. Each agency shall seek to improve the design, construction, and operation of its mobile equipment, and shall implement all life-cycle cost-effective energy efficiency measures that result in cost savings while improving mission performance. To the extent that such measures are life-cycle cost-effective, agencies shall consider enhanced use of alternative or renewable-based fuels.

Sec. 406. Management and Government Performance. Agencies shall use the following management strategies in meeting the goals of this order.

(a) Awards. Agencies shall use employee incentive programs to reward exceptional performance in implementing this order.

(b) Performance Evaluations. Agencies shall include successful implementation of provisions of this order in areas such as Energy Savings Performance Contracts, sustainable design, energy efficient procurement, energy efficiency, water conservation, and renewable energy projects in the position descriptions and performance evaluations of agency heads, members of the agency energy team, principal program managers, heads of field offices, facility managers, energy managers, and other appropriate employees.

(c) Retention of Savings and Rebates. Agencies granted statutory authority to retain a portion of savings generated from efficient energy and water management are encouraged to permit the retention of the savings at the facility or site where the savings occur to provide greater incentive for that facility and its site managers to undertake more energy management initiatives, invest in renewable energy systems, and purchase electricity from renewable energy sources.

(d) Training and Education. Agencies shall ensure that all appropriate personnel receive training for implementing this order.

> (1) DOE, DOD, and GSA shall provide relevant training or training materials for those programs that they make available to all Federal agencies relating to the energy management strategies contained in this order.
>
> (2) The Federal Acquisition Institute and the Defense Acquisition University shall incorporate into existing procurement courses information on Federal energy management tools, including Energy Savings Performance Contracts, utility energy-efficiency service contracts, ENERGY STAR® and other energy-efficient products, and life-cycle cost analysis.
>
> (3) All agencies are encouraged to develop outreach programs that include education, training, and promotion of ENERGY STAR® and other energy-efficient products for Federal purchase card users. These programs may include promotions with billing statements, user training, catalogue awareness, and exploration of vendor data collection of purchases.

(e) Showcase Facilities. Agencies shall designate exemplary new and existing facilities with significant public access and exposure as showcase facilities to highlight energy or water efficiency and renewable energy improvements.

Part 5 - Technical Assistance

Sec. 501. Within 120 days of this order, the Director of OMB shall:

(a) Develop and issue guidance to agency budget officers on preparation of annual funding requests associated with the implementation of the order for the FY 2001 budget;

(b) In collaboration with the Secretary of Energy, explain to agencies how to retain savings and reinvest in other energy and water management projects; and

(c) In collaboration with the Secretary of Energy through the Office of Federal Procurement Policy, periodically brief agency procurement executives on the use of Federal energy management tools, including Energy Savings Performance Contracts, utility energy-efficiency service contracts, and procurement of energy efficient products and electricity from renewable energy sources.

Sec. 502. Within 180 days of this order, the Secretary of Energy, in collaboration with other agency heads, shall:

(a) Issue guidelines to assist agencies in measuring energy per square foot, per unit of production, or other applicable unit in industrial, laboratory, research, and other energy-intensive facilities;

(b) Establish criteria for determining which facilities are exempt from the order. In addition, DOE must provide guidance for agencies to report proposed exemptions;

(c) Develop guidance to assist agencies in calculating appropriate energy baselines for previously exempt facilities and facilities occupied after 1990 in order to measure progress toward goals;

(d) Issue guidance to clarify how agencies determine the life-cycle cost for investments required by the order, including how to compare different energy and fuel options and assess the current tools;

(e) Issue guidance for providing credit toward energy efficiency goals for cost-effective projects where source energy use declines but site energy use increases; and

(f) Provide guidance to assist each agency to determine a baseline of water consumption.

Sec. 503. Within 1 year of this order, the Secretary of Energy, in collaboration with other agency heads, shall:

(a) Provide guidance for counting renewable and highly efficient energy projects and purchases of electricity from renewable and highly efficient energy sources toward agencies' progress in reaching greenhouse gas and energy reduction goals;

(b) Develop goals for the amount of energy generated at Federal facilities from renewable energy technologies;

(c) Support efforts to develop standards for the certification of low environmental impact hydropower facilities in order to facilitate the Federal purchase of such power;

(d) Work with GSA and DLA to develop a plan for purchasing advanced energy products in bulk quantities for use in by multiple agencies;

(e) Issue guidelines for agency use estimating the greenhouse gas emissions attributable to facility energy use. These guidelines shall include emissions associated with the production, transportation and use of energy consumed in Federal facilities; and

(f) Establish water conservation goals for Federal agencies.

Sec. 504. Within 120 days of this order, the Secretary of Defense and the Administrator of GSA, in consultation with other agency heads, shall develop and issue sustainable design and development principles for the siting, design, and construction of new facilities.

Sec. 505. Within 180 days of this order, the Administrator of GSA, in collaboration with the Secretary of Defense, the Secretary of Energy, and other agency heads, shall:

(a) Develop and issue guidance to assist agencies in ensuring that all project cost estimates, bids, and agency budget requests for design, construction, and renovation of facilities are based on life-cycle costs. Incentives for contractors involved in facility design and construction must be structured to encourage the contractors to design and build at the lowest life-cycle cost;

(b) Make information available on opportunities to purchase electricity from renewable energy sources as defined by this order. This information should accommodate relevant State regulations and be updated periodically based on technological advances and market changes, at least every 2 years;

(c) Develop Internet-based tools for both GSA and DLA customers to assist individual and agency purchasers in identifying and purchasing ENERGY STAR® and other energy-efficient products for acquisition; and

(d) Develop model lease provisions that incorporate energy efficiency and sustainable design.

Part 6 - General Provisions

Sec. 601. Compliance by Independent Agencies. Independent agencies are encouraged to comply with the provisions of this order.

Sec. 602. Waivers. If an agency determines that a provision in this order is inconsistent with its mission, the agency may ask DOE for a waiver of the provision. DOE will include a list of any waivers it grants in its Federal Energy Management Program annual report to the Congress.

Sec. 603. Scope. (a) This order is intended only to improve the internal management of the Executive branch and is not intended to create any right, benefit, or trust responsibility, substantive or procedural, enforceable by law by a party against the United States, its agencies, its officers, or any other person.

(b) This order applies to agency facilities in any State of the United States, the District of Columbia, the Commonwealth of Puerto Rico, Guam, American Samoa, the United States Virgin Islands, the Northern Mariana Islands, and any other territory or possession over which the United States has jurisdiction. Agencies with facilities outside of these areas, however, are encouraged to make best efforts to comply with the goals of this order for those facilities. In addition, agencies can report energy improvements made outside the United States in their annual report to the President; these improvements may be considered in agency scorecard evaluations.

Sec. 604. Revocations. Executive Order 12902 of March 9, 1994, Executive Order 12759 of April 17, 1991, and Executive Order 12845 of April 21, 1993, are revoked.

Sec. 605. Amendments to Federal Regulations. The Federal Acquisition Regulation and other Federal regulations shall be amended to reflect changes made by this order, including an amendment to facilitate agency purchases of electricity from renewable energy sources.

Part 7 – Definitions

For the purposes of this order:

Sec. 701. "Acquisition" means acquiring by contract supplies or services (including construction) by and for the use of the Federal Government through purchase or lease, whether the supplies or services are already in existence or must be created, developed, demonstrated, and evaluated. Acquisition begins at the point when agency needs are established and includes the description of requirements to satisfy agency needs, solicitation and selection of sources, award of contracts, contract financing, contract

performance, contract administration, and those technical and management functions directly related to the process of fulfilling agency needs by contract.

Sec. 702. "Agency" means an Executive agency as defined in 5 U.S.C. 105. For the purpose of this order, military departments, as defined in 5 U.S.C. 102, are covered under the auspices of DOD.

Sec. 703. "Energy Savings Performance Contract" means a contract that provides for the performance of services for the design, acquisition, financing, installation, testing, operation, and where appropriate, maintenance and repair, of an identified energy or water conservation measure or series of measures at one or more locations. Such contracts shall provide that the contractor must incur costs of implementing energy savings measures, including at least the cost (if any) incurred in making energy audits, acquiring and installing equipment, and training personnel in exchange for a predetermined share of the value of the energy savings directly resulting from implementation of such measures during the term of the contract. Payment to the contractor is contingent upon realizing a guaranteed stream of future energy and cost savings. All additional savings will accrue to the Federal Government.

Sec. 704. "Exempt facility" or "Exempt mobile equipment" means a facility or a piece of mobile equipment for which an agency uses DOE-established criteria to determine that compliance with the Energy Policy Act of 1992 or this order is not practical.

Sec. 705. "Facility" means any individual building or collection of buildings, grounds, or structure, as well as any fixture or part thereof, including the associated energy- or water-consuming support systems, which is constructed, renovated, or purchased in whole or in part for use by the Federal Government. It includes leased facilities where the Federal Government has a purchase option or facilities planned for purchase. In any provision of this order, the term "facility" also includes any building 100 percent leased for use by the Federal Government where the Federal Government pays directly or indirectly for the utility costs associated with its leased space. The term also includes Government-owned contractor-operated facilities.

Sec. 706. "Industrial facility" means any fixed equipment, building, or complex for production, manufacturing, or other processes that uses large amounts of capital equipment in connection with, or as part of, any process or system, and within which the majority of energy use is not devoted to the heating, cooling, lighting, ventilation, or to service the water heating energy load requirements of the facility.

Sec. 707. "Life-cycle costs" means the sum of the present values of investment costs, capital costs, installation costs, energy costs, operating costs, maintenance costs, and disposal costs, over the lifetime of the project, product, or measure. Additional guidance on measuring life-cycle costs is specified in 10 C.F.R. 436.19.

Sec. 708. "Life-cycle cost-effective" means the life-cycle costs of a product, project, or measure are estimated to be equal to or less than the base case (i.e., current or standard practice or product). Additional guidance on measuring cost-effectiveness is specified in 10 C.F.R. 436.18 (a), (b), and (c), 436.20, and 436.21.

Sec. 709. "Mobile equipment" means all Federally owned ships, aircraft, and nonroad vehicles.

Sec. 710. "Renewable energy" means energy produced by solar, wind, geothermal, and biomass power.

Sec. 711. "Renewable energy technology" means technologies that use renewable energy to provide light, heat, cooling, or mechanical or electrical energy for use in facilities or other activities. The term also means the use of integrated whole-building designs that rely upon renewable energy resources, including passive solar design.

Sec. 712. "Source energy" means the energy that is used at a site and consumed in producing and in delivering energy to a site, including, but not limited to, power generation, transmission, and distribution losses, and that is used to perform a specific function, such as space conditioning, lighting or water heating.

Sec. 713. "Utility" means public agencies and privately owned companies that market, generate, and/or distribute energy or water, including electricity, natural gas, manufactured gas, steam, hot water, and chilled water as commodities for public use and that provide the service under Federal, State, or local regulated authority to all authorized customers. Utilities include Federally owned nonprofit producers, municipal organizations, and investor or privately owned producers regulated by a State and/or the Federal Government; cooperatives owned by members and providing services mostly to their members; and other nonprofit State and local government agencies serving in this capacity.

Sec. 714. "Utility energy-efficiency service" means demand-side management services provided by a utility to improve the efficiency of use of the commodity (electricity, gas, etc.) being distributed. Services can include, but are not limited to, energy efficiency and renewable energy project auditing, financing, design, installation, operation, maintenance, and monitoring.

William J. Clinton

The White House, June 3, 1999

Appendix E: Glossary of Terms

AEF:	Air Expeditionary Force
AEW:	Air Expeditionary Wing
AOR:	Area of Responsibility
ASIP:	Aircraft Structural Integrity Program
BDI:	Bomb Damage Indication
CAIG:	Cost Analysis and Improvement Group
CALCM	Conventional Air Launched Cruise Missile
CAS:	Close Air Support
CONPLAN:	Concept of Operations Plan
CONOPs:	Concept of Operations
CONUS:	Continental United States
COTS	Commercial Off The Shelf
Counterair:	Operations conducted to attain/maintain air superiority by destroying/neutralizing enemy (air) forces (may include air-air, air-ground, and ground-air operations)

- Defensive Counterair (DCA): Operations to detect, identify, intercept, destroy enemy air and missile forces attempting to penetrate/attack friendly airspace
- Offensive Counterair (OCA): Operations to destroy, disrupt or limit enemy airpower as close to its source as possible (normally over enemy territory)

Counterland:

- Close Air Support (CAS): Air actions against hostile forces which are in close proximity to friendly ground forces and which required detailed coordination with the fire and movement of the supported ground forces.
- Interdiction: Air actions to divert, disrupt, delay, or destroy the enemy's surface military potential before it can be used effectively against friendly forces.

Joint:	Operations involving more than one military service from the same nation (i.e., multiservice)
Combined:	Operations Involving (one or more) services from more than one nation (i.e., multinational)
DMS:	Diminishing Manufacturing Sources
DSB	Defense Science Board
ECM	Electronic Countermeasures
EMD:	Engineering and Manufacturing Development
EPNdB	Effective Perceived Noise Level (dB)
ESPC:	Energy Savings Performance Contracting
EO:	Executive Order
FOD	Foreign Object Damage

FOL:	Forward Operating Location
FSA:	Future Strike Aircraft
FSIP:	Functional Systems Integrity Program
GWAPS:	Gulf War Air Power Survey
JASSM	Joint Air to Surface Standoff Missile
JDAM	Joint Direct Attack Munition
JSOW	Joint Standoff Weapon
LRSA:	Long-Range Strike Aircraft
M&V:	Measurement and Verification
MAP:	Mission Area Plan
MC:	Mission Capable
MOB:	Main Operating Base
MRSPs:	Mobility Readiness Spares Packages
MTW:	Major Theater War
NGBS:	Next Generation Bomber Study
OC-ALC:	Oklahoma City Air Logistics Center, location of B-52H System Program Office
OEF:	Operation Enduring Freedom (Afghanistan)
OEM:	Original Equipment Manufacturer
OSD:	Office of the Secretary of Defense
PAA	Primary Assigned Aircraft
SA:	Situational Awareness
SEAD:	Suppression of Enemy Air Defenses
SECAF:	Secretary of the Air Force
SIOP:	Strategic Integrated Operational Plan
SPO:	System Program Office
SOF:	Special Operating Forces
SSC	Small Scale Contingency
Strategic Attack:	Operations carried out directly against enemy's centers of gravity to degrade capability and will to carry out aggressive actions (typical targets--command and control, electrical power, petroleum, industry, weapons manufacturing, logistics support). Often directed against "heartland"-- may bypass enemy's forces in the field.
TAI	Total Aircraft Inventory
UCAV	Unmanned (Uninhabited) Combat Air Vehicle
USSTRATCOM:	United States Strategic Command